INSECT PESTS

AND

FUNGUS DISEASES OF FRUIT AND HOPS

CAMBRIDGE UNIVERSITY PRESS

C. F. CLAY, MANAGER

LONDON : FETTER LANE, E.C. 4

LONDON : H. K. LEWIS AND CO., LTD.,
136 Gower Street, W.C. 1

LONDON : WILLIAM WESLEY AND SON,
28 Essex Street, Strand, W.C. 2

NEW YORK : THE MACMILLAN CO.

BOMBAY, CALCUTTA, MADRAS : MACMILLAN AND CO., LTD.

TORONTO : THE MACMILLAN CO. OF CANADA, LTD.

TOKYO : MARUZEN-KABUSHIKI-KAISHA

INSECT PESTS
AND
FUNGUS DISEASES OF FRUIT AND HOPS

A COMPLETE MANUAL FOR GROWERS

BY

PERCIVAL J. FRYER, F.I.C., F.C.S.

TECHNICAL DIRECTOR AND CHIEF OF RESEARCH DEPARTMENT,
YALDING MANUFACTURING CO., LTD.;
MEMBER OF SOCIETY OF ECONOMIC BIOLOGISTS

CAMBRIDGE
AT THE UNIVERSITY PRESS
1920

MOTTLED UMBER MOTH

Name *Hybernia defoliaria* Class *Geometridæ*
Order *Lepidoptera*

1. General

Description

Larva (Caterpillar)

APPEARANCE.	Slender, smooth skinned, about $1\frac{1}{2}$ inches in length (mature).
COLOUR.	Chestnut brown and creamy yellow.
LOCATION.	On leaves.
PROGRESSION.	By "*looping*."
APPEARS IN	April.
DURATION.	Till end of June.
REMARKS.	On maturity they fall to the ground and enter the soil to pupate.

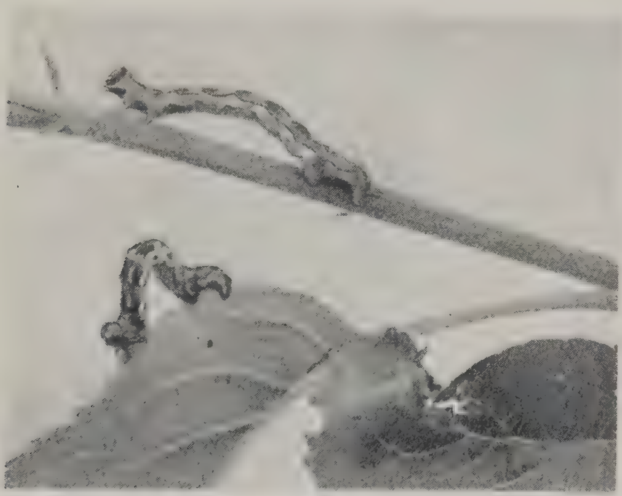


Fig. 83. Mottled Umber Caterpillars. Natural size.

Pupa (Chrysalis)

COLOUR.	Brown.
LOCATION.	In soil.
APPEARS IN	End of June.
DURATION.	4 to 7 months.

Adult Insect (Moth)

	Male	Female
SIZE ACROSS WINGS.	About $1\frac{3}{4}$ inches.	Wingless.
COLOUR (WINGS).	Yellowish brown.	—
„ (BODY).	Yellowish grey.	Mottled brown.
REMARKS.	The wingless females ascend the tree trunks.	
APPEARS IN	End October—February.	

Fig. 84. Pupa of Mottled Umber Moth. Natural size.

Ova (Eggs)

APPEARANCE.	Oval.
COLOUR.	Deep straw colour.
ARRANGEMENT.	Not systematic.
LOCATION.	Buds, twigs, bark cavities, or pruned surfaces.
APPEAR IN	October to February.
HATCH IN	April.

Distribution

Chiefly in Midlands and South of England.

Fig. 85. Mottled Umber Moth, female. Magnified ($\times 2\frac{1}{2}$). Inset, natural size.

Life-history

The moths appear from the soil at very variable times, from the end of October until February, according to the season.

The female ascends the trunk (being without wings) and is there fertilised by the winged male moth. Eggs are deposited on the

Fig. 86. Three varieties of male Mottled Umber Moths. Natural size.

twigs, buds etc. The caterpillars hatch out in April and feed upon the foliage until June when they drop to the ground and pupate under the soil.

Remarks

The caterpillar is a "looper" and very active (see page 56).

2. Economic

Trees Attacked

Apples, plums, cherries, pears, cobs, filberts; also forest trees.

Frequency of Pest

In the case of orchards near oak, or forest trees, bad attacks often occur locally.

Nature of Attack

The caterpillars devour the leaves, and often attack the fruit, especially growing cherries.

Duration of Attack

April—July.

Degree of Damage

Often serious defoliation, and damage to fruits.

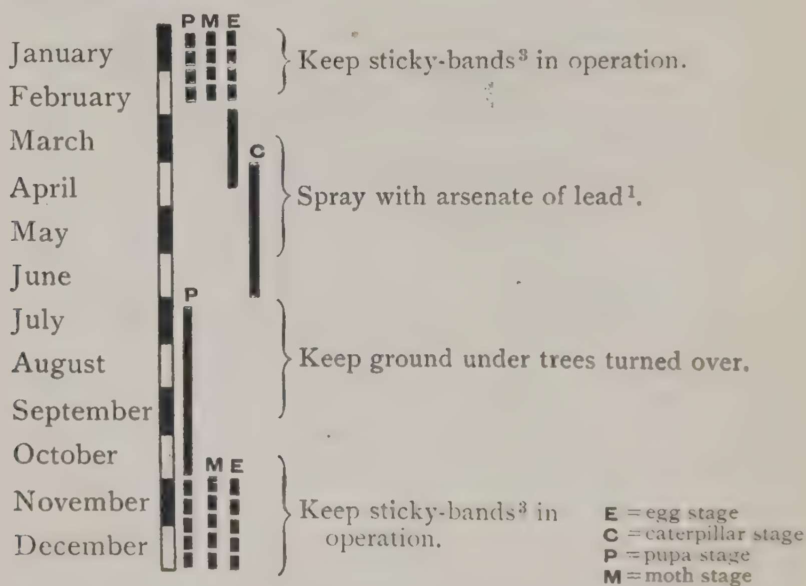
Preventive Measures

1. Keep the trees banded with sticky material (see page 404) from October onwards to catch the ascending females and prevent egg laying.
2. Turn over ground under trees in late summer and early autumn.

Remedies

1. Spray with ARSENATE OF LEAD[1].
2. Soap sprays with NICOTINE[2] or NICOTINE SUBSTITUTES in sufficient quantities will kill the young caterpillars.

Calendar of Treatment



[1] See page 397. [2] See page 436. [3] See page 404.

PEPPERED MOTH

Name *Amphidasys betularia* Class *Geometridæ*
Order *Lepidoptera*

1. General

Description

Larva (Caterpillar)

APPEARANCE.	About 2 inches when mature—resembles a small twig.
COLOUR.	Green to brown (protectively coloured).
LOCATION.	On shoots.
PROGRESSION.	By "*looping*."
APPEARS IN	Late July and August.
DURATION.	Till late October.
REMARKS.	The caterpillars are very difficult to find, as they mimic, very wonderfully, the twigs of trees.

Pupa (Chrysalis)

COLOUR.	Brown.
LOCATION.	In the ground.
APPEARS IN	Late October—November.
DURATION.	Till following June (throughout winter).

Adult Insect (Moth)

SIZE ACROSS WINGS.	$1\frac{1}{2}$ to $2\frac{1}{4}$ inches (female slightly larger).
COLOUR (WINGS).	White, speckled with black.
APPEARS IN	Late May—July.

Ova (Eggs)

ARRANGEMENT.	Singly.
LOCATION.	On leaves.
APPEAR IN	Late May—July.
HATCHING PERIOD.	3—4 weeks.

Distribution

Widespread in England.

Life-history

The moths commonly appear in June and July, and both the sexes are winged.

The caterpillars hatch out in August, and do not mature till late in the autumn, by which time they can strip the trees and the damage often pass unnoticed, since the fruit is gathered and the leaves falling.

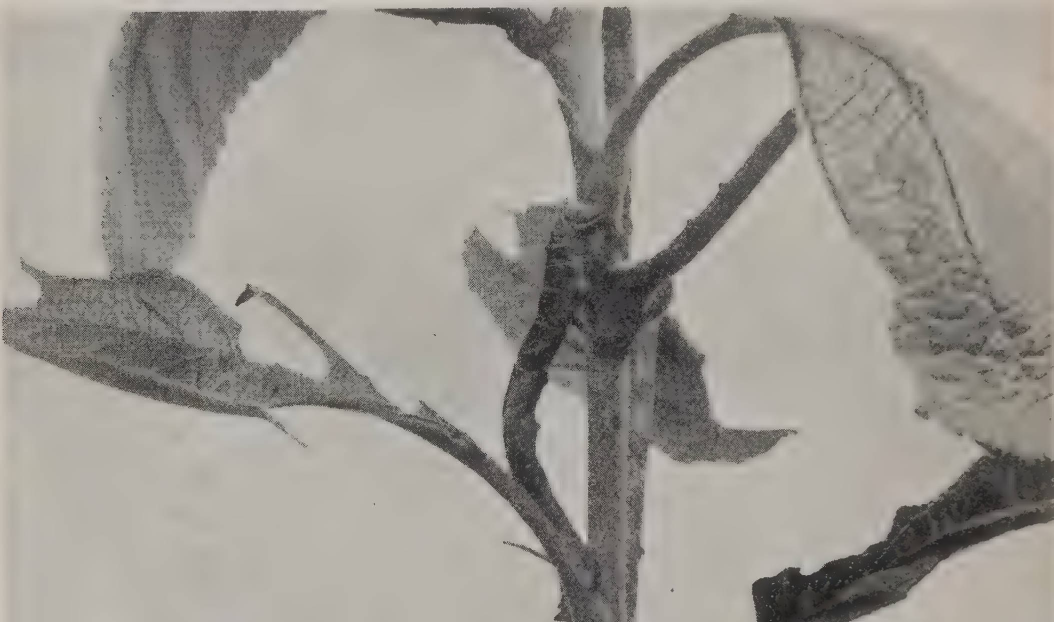


Fig. 87. Caterpillars of Peppered Moths in characteristic attitudes. Natural size.

The caterpillars also escape notice by their wonderful resemblance to twigs.

Pupation takes place in the soil in late autumn and the winter is spent in this state in the ground.

Fig. 88. Pupæ and adults of Peppered Moth.
Natural size.

2. Economic

Trees Attacked

Apples, cherries.

Frequency of Pest

Not uncommon.

Nature of Attack

The caterpillars eat the leaves of the trees in the autumn and so weaken the plant (see page 16). They are difficult to detect on account of their resemblance to dead twigs.

Degree of Damage

Often more serious than suspected : see page 16.

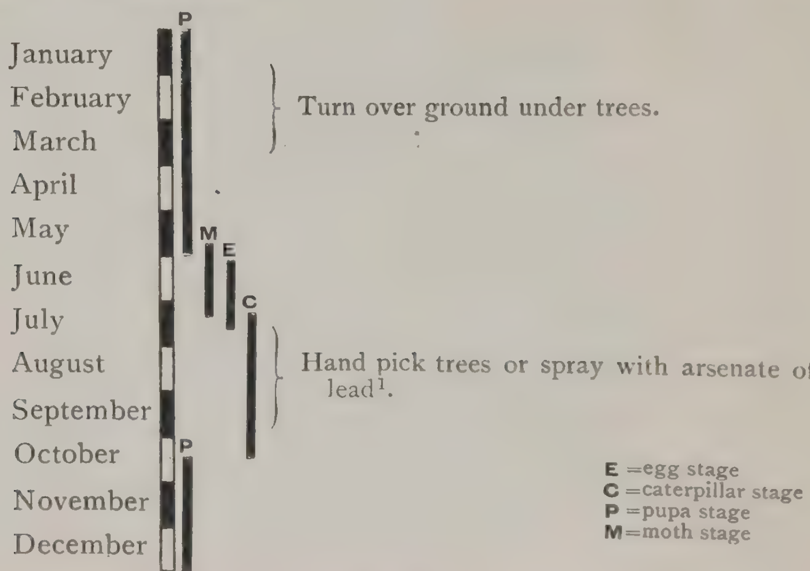
Preventive Measure

Turning the ground over under the trees in the winter and spring exposes the pupæ to the attacks of birds and fowls.

Remedies

1. Spray in the autumn with ARSENATE OF LEAD[1].
2. In small plantations it may be worth while to hand pick the trees. This is a little difficult till experience has been gained of the difference between dry twigs and the caterpillar, but it is easier to see than in the spring and summer owing to the absence of many of the leaves from the trees.

Calendar of Treatment



[1] See page 397.

PITH MOTH

Name *Blastodacna hellerella* Class *Tineidæ*
Order *Lepidoptera*

1. General

Description

Larva (Caterpillar). See fig. 92.

SIZE.	About $\frac{1}{3}$ inch full grown.
COLOUR.	Dull reddish brown with dark brown head.
LOCATION.	(1) leaves, (2) inside bud, (3) under rind of shoot, (4) tunnelling in shoot.
APPEARS IN	Late summer.
DURATION.	Throughout winter till end of following June.

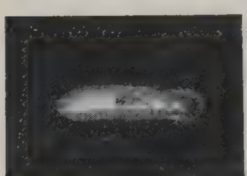


Fig. 89. Pupa of Pith Moth. Magnified.

Fig. 90. Pith Moth. Natural size.

Pupa (Chrysalis)

SIZE.	About $\frac{1}{4}$ inch long.
COLOUR.	Yellowish: head and tip mahogany red
LOCATION.	Near end of shoot (inside).
APPEARS IN	June.
DURATION.	2—3 weeks.

Adult Insect (Moth)

SIZE ACROSS WINGS.	Up to $\frac{1}{2}$ inch.
COLOUR (WINGS).	Fore-wings, black or mottled brown. Hind-wings, grey; densely fringed.
REMARKS.	Extremely active.
APPEARS IN	July and August.

Distribution

Widespread in Britain.

Life-history

The small, very active moths appear in July and August, and lay eggs which have not yet been discovered. These hatch out into minute caterpillars which appear to feed first on the leaves, and when larger enter the buds, and afterwards bore into the shoots near the bud and remain in this position during the winter.

Fig. 91. Withered truss showing hole (×) made by the caterpillar which is the sign of the Pith Moth, and distinguishes it from injuries caused by other diseases. Natural size.

Their presence may be detected by a small round hole near the bud, and a brown blister where they have been working. In spring they bore up into the shoot and pupate in this position, when mature, in June.

2. Economic

Trees Attacked

Apples, pears, especially nursery stock and bush fruit.

Susceptible Varieties

Worcesters.

Nature of Attack

The leaves and blossoms flag and then turn brown and die : the dead parts may remain on the trees for some time before falling off. Distinguished from BUD MOTH (page 65) by the absence of leaves and blossom spun together, and by the whole mass dying back. In appearance very similar to CANKER.

Fig. 92. Shoot cut open to show Pith Moth Caterpillar in position. Natural size.

Degree of Damage

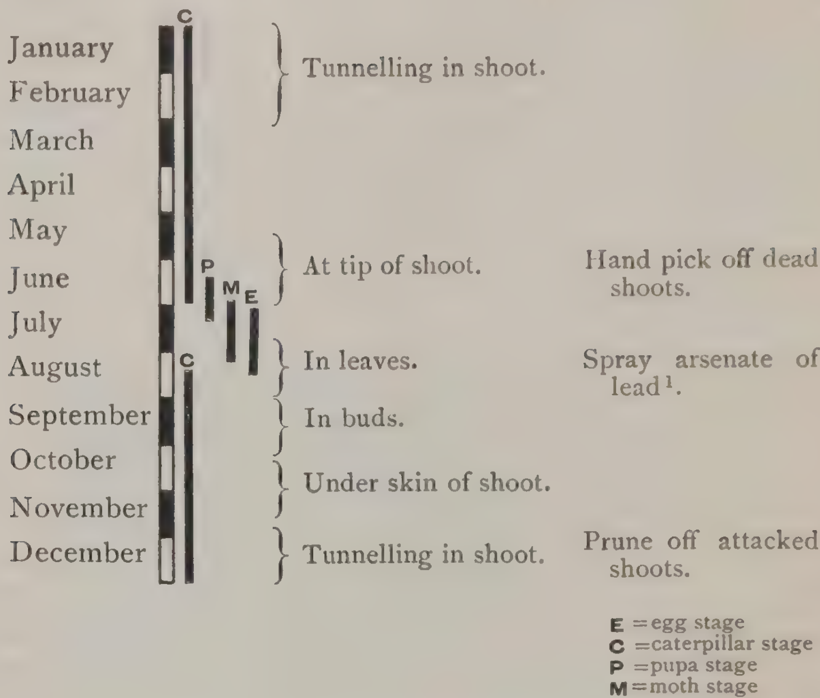
Sometimes very serious.

Remedies

1. In case of small trees, hand pick the dead shoots off before the moths emerge in June.
2. In winter, prune off the attacked shoots.
3. Spray heavily with ARSENATE OF LEAD[1] as soon as the fruit is gathered.

[1] See page 397.

Calendar of Treatment



PLUM FRUIT MOTH (Red plum maggot)

Name *Opadia funebrana* Class *Tineidæ* Order *Lepidoptera*

1. General

Description

Larva (Caterpillar)

SIZE.	About $\frac{5}{8}$ inch (mature).
COLOUR.	Red, sides often yellow; head shiny brown, black spots on 7, 8, 9, 11 and 13 segments.
LOCATION.	Inside fruit (plums).
APPEARS IN	July.
DURATION.	Till following summer.
REMARKS.	The grubs leave the fruits about the end of August and shelter under the bark or in rubbish, spinning a cocoon of grey silk.

[1] See page 397.

Pupa (Chrysalis)

APPEARANCE.	In the caterpillar cocoons.
COLOUR.	Yellowish, with dark brown "tail."
LOCATION.	In crevices of bark or other sheltered spots.

Adult Insect (Moth)

SIZE ACROSS WINGS.	About ½ inch.
COLOUR (WINGS).	Purplish grey, clouded.
APPEARS IN	June and July.

Ova (Eggs)

ARRANGEMENT.	Singly.
LOCATION.	At base of stalk.
APPEAR IN	June and July.
HATCHING PERIOD.	About 10 days.

Fig. 93. Diagram of fruit opened showing Caterpillar of Plum Fruit Moth. Natural size.

Distribution

Fairly widespread.

Life-history

The moths appear in middle summer and lay a single egg on the fruit-stalk. The caterpillar, on hatching, enters the fruit and lives inside until mature, at about the end of August, when it leaves the plum and finds shelter under the bark or beneath rubbish etc.; spinning a cocoon of grey silk and wintering in this condition. It pupates in the following summer.

2. Economic

Trees Attacked

Plums and damsons.

Frequency of Pest

Fairly common in West of England.

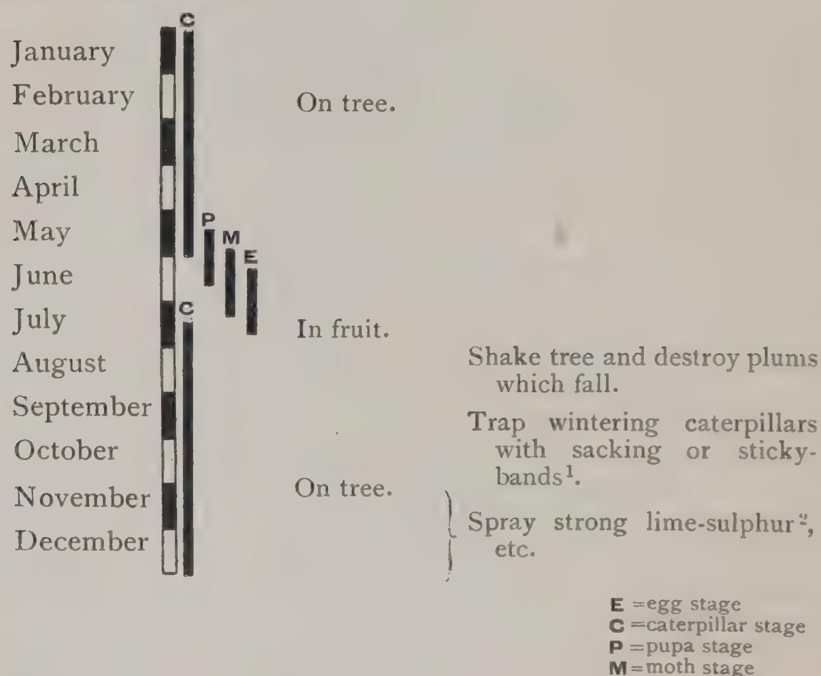
Nature of Attack

The fruit is entered by the maggot which frequently causes it to fall before it is quite ripe. There is also much bitter "frass" formed in the interior of the plum which makes it unpalatable.

Remedies

1. Where practicable prepare TRAPS of sacking tied round the trunks of the trees (as for Codling Moth, see page 92) to catch the wintering caterpillars. STICKY-BANDS[1] are also good.
2. Apply strong LIME-SULPHUR[2], or other winter wash, during the dormant season.
3. Shake the tree in the summer, and destroy the prematurely ripe plums which fall. These contain the maggots (future trouble is thus prevented).

Calendar of Treatment



[1] See page 404. [2] See page 612.

RASPBERRY MOTH (Red raspberry grub)

Name *Tinea rubiella* Class *Tineidæ* Order *Lepidoptera*

1. General

Description

Larva (Caterpillar)

Size.	About ¼ inch when full grown.
Colour.	At first pale, then pink and finally reddish: head black or brown.
Location.	(1) in flowers, (2) in shelter in cocoons, (3) in buds, (4) in cane.
Appears in	June (from eggs), middle to end of March (from winter quarters).
Duration.	Throughout winter till following May.

Fig. 94. Diagram of Caterpillars of Raspberry Moth. Natural size.

Pupa (Chrysalis)

Size.	About ¼ inch long.
Colour.	Yellowish red.
Location.	In cavity in cane or shoot.
Appears in	May.
Duration.	15 to 30 days.

Adult Insect (Moth)

Size across wings.	Up to ½ inch.
Colour (wings).	Front—brown with yellow spots. Back—brown.
" (body).	Brown.
Appears in	End of May and June.

Ova (Eggs)

LOCATION.	On the flowers.
APPEAR IN	End of May and June.
DURATION.	5 to 7 days.

Distribution

Widely distributed in Britain.

Life-history

The small moths appear at the end of May and June, and are very active, flying both by day and night: they may be seen over the canes or on the flowers at this period.

The eggs, which are laid, usually, in the flowers, hatch out, and the minute whitish caterpillars penetrate to the base of the bloom where they remain (not being harmful at this stage) until the fruit is almost ripe, when they drop to the ground and seek a secure shelter for the winter[1], where they spin a small cocoon of grey silk.

In late March they issue from their hiding places and enter the base of the buds. Here the caterpillar becomes pink and, later on, red. It feeds on the bud and then penetrates into the pith of the shoot. The attacked buds and shoots all die before long.

Remarks

When the caterpillar is mature, in May, it makes a hollow chamber in the cane or shoot and here pupates.

2. Economic

Fruit-plants Attacked

Raspberry, also blackberry and probably loganberry.

Frequency of Pest

Common.

Nature of Attack

The buds and shoots are attacked by the caterpillars with the result that the buds either do not open, or they expand and

[1] Either on the canes under bark etc. or under stones, debris etc.

die and finally all the leaves and blossoms perish on the attacked shoots.

Degree of Damage

Very serious: entire crops may be ruined.

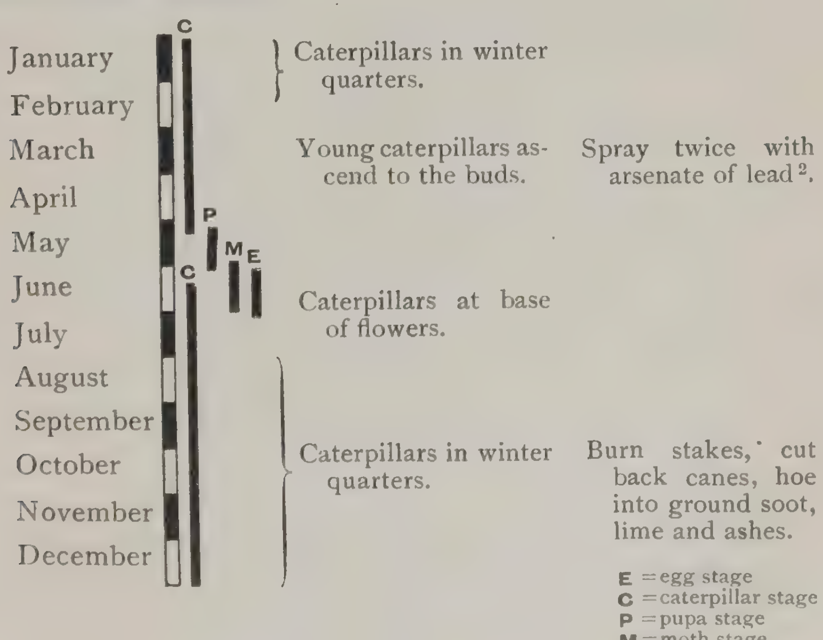
Preventive Measures

1. Remove and burn all old stakes in the winter.
2. Cut back all old canes close to the ground in the autumn and burn them at once.
3. Hoe the ground around canes deeply in the winter, and mix in soot, lime and ashes.
4. In small house-gardens it is a good plan to apply BANDING COMPOSITION[1] to the tops of the canes under shoots so as to catch the ascending caterpillars. This should be done in *early March.*

Remedy

Apply a spray of ARSENATE OF LEAD[2] late in March, and a further spray a few days later on. This will kill the caterpillars, who will take a dose of the poison on eating their way into the buds.

Calendar of Treatment



[1] See page 404.   [2] See page 397.

SWIFT MOTH

Name *Hepialus lupulinus* Family *Hepalidæ*
Order *Lepidoptera*

1. General

Description

Larva (Caterpillar)

SIZE.	About $1\frac{1}{2}$ inches when full grown.
COLOUR.	Dull white, with shiny brown head.
LOCATION.	In the ground.
APPEARS IN	June and July.
DURATION.	Throughout winter to following April.

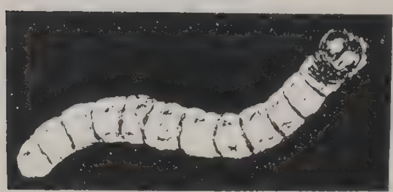


Fig. 95. Diagram of Caterpillar of Swift Moth. Natural size.

Fig. 96. Pupæ of Swift Moth. Natural size.

Pupa (Chrysalis)

APPEARANCE.	In cocoon, or naked: about $\frac{2}{3}$ inch long with 5 rows of spines on abdomen.
COLOUR.	Brown.
LOCATION.	In soil.
APPEARS IN	April.
DURATION.	2 to 3 weeks.

Adult Insect (Moth)

SIZE ACROSS WINGS.	About 1 to $1\frac{1}{4}$ inches.
COLOUR (WINGS).	Pale brown with white streak (variable).
APPEARS IN	Middle May.
REMARKS.	The male moth has a curious, jerky habit of flight.

Ova (Eggs)

ARRANGEMENT.	Dropped by the females during flight.
LOCATION.	On ground.
HATCHING PERIOD.	About 10 days.

Distribution

Widespread.

Fig. 97. Swift Moths. Natural size.

Life-history

The moths emerge from the ground from the middle of May onwards for a few weeks, and appear in flight at dusk. The male moth flies with a swift jerky movement (hence name). The eggs are *dropped by the female in flight* and fall to the ground, hatching out in about a week. The young caterpillar then enters the soil

and commences feeding upon the roots of the plants attacked, till the following spring, when it pupates in the soil, either naked or spinning a cocoon of grey silk.

2. Economic

Plants Attacked

Strawberries. Also many other roots of plants.

Frequency of Pest

Fairly common.

Nature of Attack

The roots are attacked, first the young rootlets, then the main roots even up to the crown of the plant (in which case it is entirely destroyed).

Degree of Damage

Often serious, especially during mild winters.

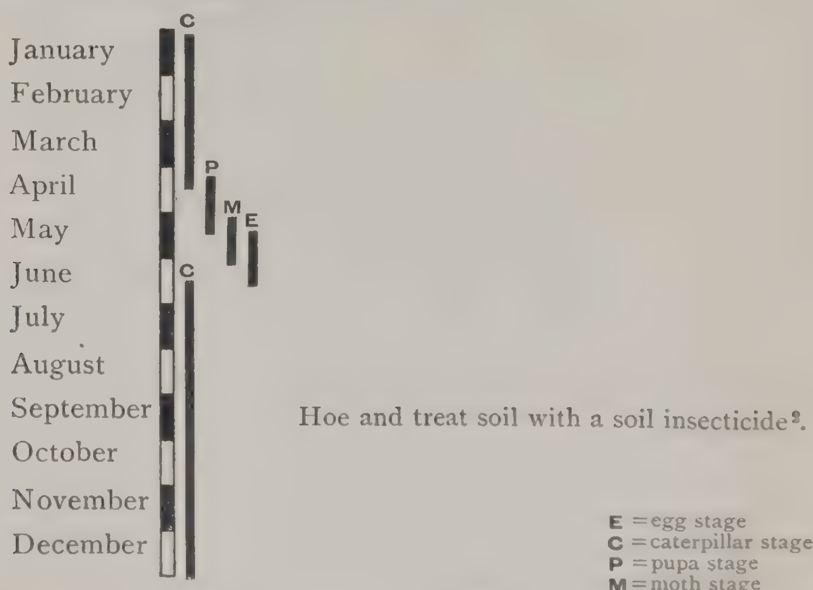
Natural Enemies

A species of bug (*Anthocoris*[1]). Also a fungus (*Cordyceps entomorrhiza*) often attacks it, filling its body with the mould substance.

Remedies

1. Hoe the beds constantly.
2. Work into the soil a SOIL INSECTICIDE[2], best in early autumn.
3. Dress with one or more of the following: soot, kainit, wood ashes, gas lime.

Calendar of Treatment



[1] Theobald. [2] See page 433.

TORTOISESHELL BUTTERFLY (large)

Name *Vanessa polychloros* Order *Lepidoptera*

1. General

Description

Larva (Caterpillar)

SIZE.	About 2 inches when full grown.
COLOUR.	Black or brownish black, with yellow side lines.
LOCATION.	On leaves.
APPEARS IN	May.
DURATION.	About 6 weeks.
REMARKS.	The caterpillars first live in colonies, and afterwards disperse over the leaves.

Fig. 98. Caterpillar and Pupa of Large Tortoiseshell Butterfly. Natural size.

Pupa (Chrysalis)

APPEARANCE.	Suspended head downwards: has two rows of blunt spines.
COLOUR.	Grey ringed with black: yellow at end.

LOCATION.	Attached to twigs and leaves.
APPEARS IN	Mid June.
DURATION.	3 to 4 weeks (variable).

Adult Insect (Butterfly)

SIZE ACROSS WINGS.	$2\frac{1}{2}$ to 3 inches.
COLOUR (WINGS).	Rich orange-brown etc. (see fig.).
,, (BODY).	Brown, hairy.
APPEARS IN	July.
DURATION.	Winters in sheltered places, and lays eggs in following May.

Fig. 99. Large Tortoiseshell Butterfly. Natural size.

Ova (Eggs)

ARRANGEMENT.	In rings around twigs.
LOCATION.	On twigs.
APPEAR IN	May.

Distribution

Widespread.

Life-history

This beautiful butterfly appears on the wing in July, and winters in sheltered places, laying its eggs in rings around the branches in the following May.

The young caterpillars first live in colonies, but afterwards disperse over the trees. They pupate in mid June, suspending themselves head downwards from the branches for this purpose.

2. Economic

Trees Attacked

Cherries, apples. More often the elm, aspen, sallow, etc.

Frequency of Pest

Not frequent.

Nature of Attack

Foliage eaten.

Degree of Damage

Occasionally serious.

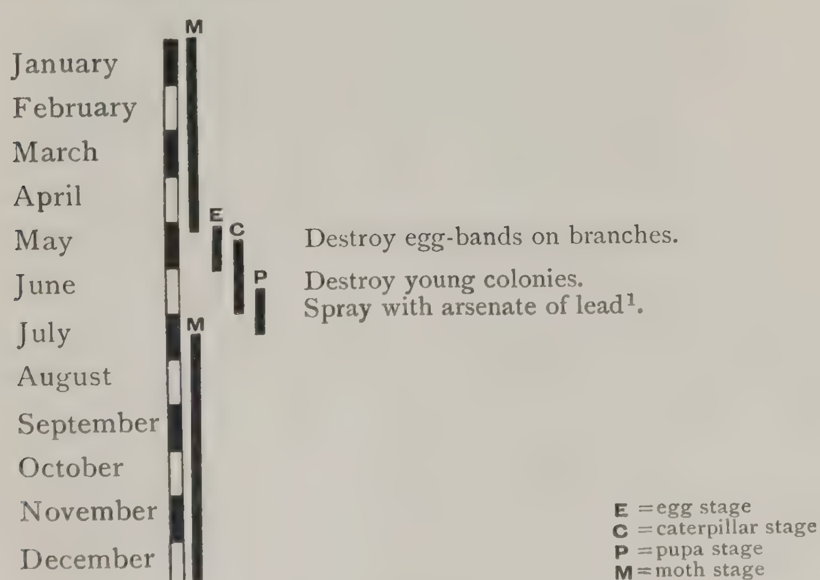
Preventive Measure

Destroy the egg-rings on branches when they appear if this is possible.

Remedies

1. Collect and destroy the young colonies of caterpillars.
2. Spray the tree with ARSENATE OF LEAD[1].

Calendar of Treatment



[1] See page 397.

TORTRIX MOTHS

A large number of these small moths attack fruit trees, and cause a great amount of damage every year.

The BUD MOTH belongs to this group, also the CODLING, but these are specially described on account of their serious attacks upon the young blossoms and fruit respectively.

The **caterpillars** can be recognised by their trick of *wriggling backwards* when touched, and their great activity.

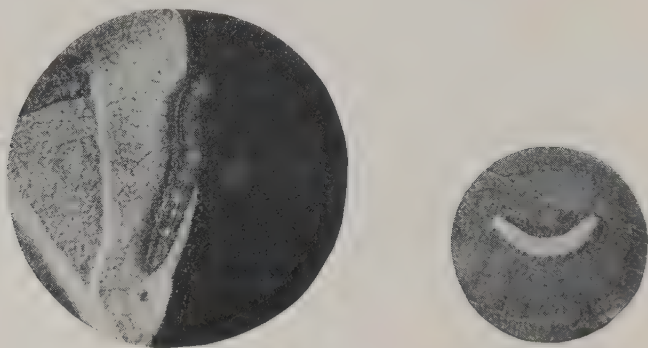


Fig. 100. Two varieties of Tortrix Caterpillars. Natural size.

Most of them feed also upon the blossom, but, except in the case of the Bud Moth, the leaves are chiefly attacked. They almost invariably *unite leaves* (*and blossom*) *together* by silken threads and feed between them, and the pupal stage is passed in the pockets so formed.

The following calendar shews roughly the dates of the different stages, although variations sometimes occur, some caterpillars passing the winter in dead leaves, etc.

Treatment follows the general lines for other caterpillars, but the spraying should be done while the caterpillars are very young and before they spin the leaves together.

Calendar

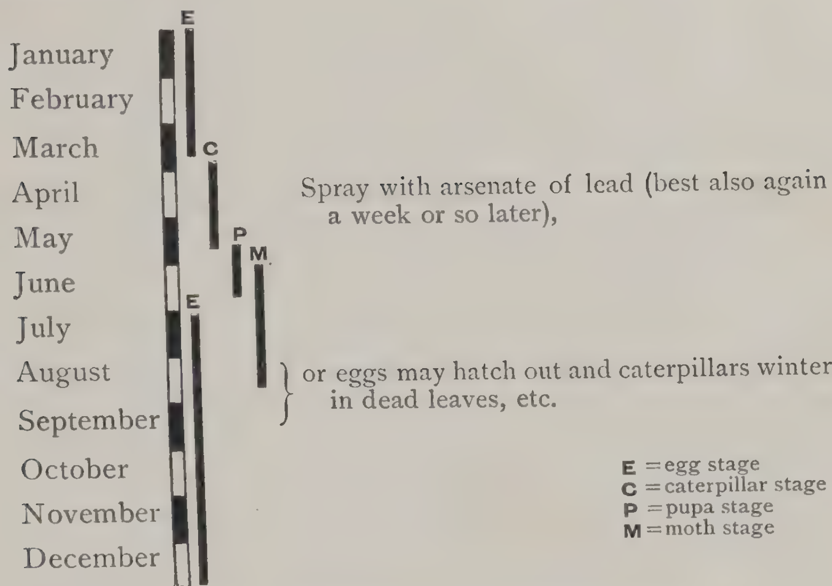


Fig. 101. Various Tortrix Moths. 1, Allied Bud. 2, Common Tortrix. 3, *Spilonota ribeana*. 4, Allied Tortrix (*Heparana*). Natural size.

The following are the scientific names of the chief Tortrix Moths recorded as pests on fruit:

Scientific Name	Common Name	Fruit attacked
Tortrix ribeana	The common Tortrix	Apples, plums
Tortrix heparana	Allied Tortrix	,,
Tortrix rosana	——	Apples, plums, cherries, pears, etc.
Sideria achatana	——	Apples
Penthina variegana	Allied Bud Moth	Apples, pears
Penthina pruniata	——	Plums, apples, cherries, nuts
Tortrix podana	——	Apples, currants
Tortrix relinquana	——	Vines
Tortrix viridana	Green oak Tortrix	Chestnuts
Carpocapsa splendidana	Nut fruit Tortrix	,,

Fig. 102. Green Pug Moths. Occasionally pests on fruit. Natural size.

TORTRIX MOTH (common Tortrix)

Name *Tortrix ribeana* Class *Tortricidæ* Order *Lepidoptera*

1. General

Description

Larva (Caterpillar)

APPEARANCE.	Slightly hairy.
COLOUR.	Dark olive-green with black spots. Head, dark brown.
LOCATION.	On or inside spun leaves.
APPEARS IN	April and May.
DURATION.	Till June.

Fig. 103. Caterpillar of Common Tortrix. Magnified (× 3). Inset, natural size.

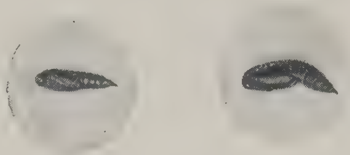


Fig. 104. Common Tortrix Moth pupæ. Natural size.

Pupa (Chrysalis)

APPEARANCE.	Small, slender.
COLOUR.	Reddish brown.
LOCATION.	Between leaves spun together.
APPEARS IN	June.
DURATION.	2 to 3 weeks.

Adult Insect (Moth)

Size across wings.	About $\frac{2}{3}$ inch.
Colour (wings).	Front—pale yellowish brown, with darker markings; hind—slaty grey.
Appears in	End of June and July.

Ova (Eggs)

Appearance.	Round, transparent.
Colour.	Yellowish.
Arrangement.	In batches.
Location.	On leaves or branches.
Appear in	End of June to July.
Duration.	Throughout the winter till following spring.

Fig. 105. Common Tortrix Moths. Natural size.

Distribution

Widespread.

Life-history

The winter is usually passed in the egg stage, but some eggs may hatch out in the late summer and the caterpillar then winters spun up in leaves or under rubbish.

The eggs hatch out fairly late in the spring and the caterpillars first feed upon the surface of the leaf, and then spin leaves together, and live in the pocket so formed. They mature in June and the pupa is formed in the leaf pocket, which is then usually withered. The moths hatch out in late June and July and lay the eggs upon the leaves or shoots.

2. Economic

Trees Attacked

Apples, plums and many other trees and bushes.

Frequency of Pest

Very common.

Nature of Attack

The leaves and sometimes the blossoms are attacked and wither. Leaves are spun together.

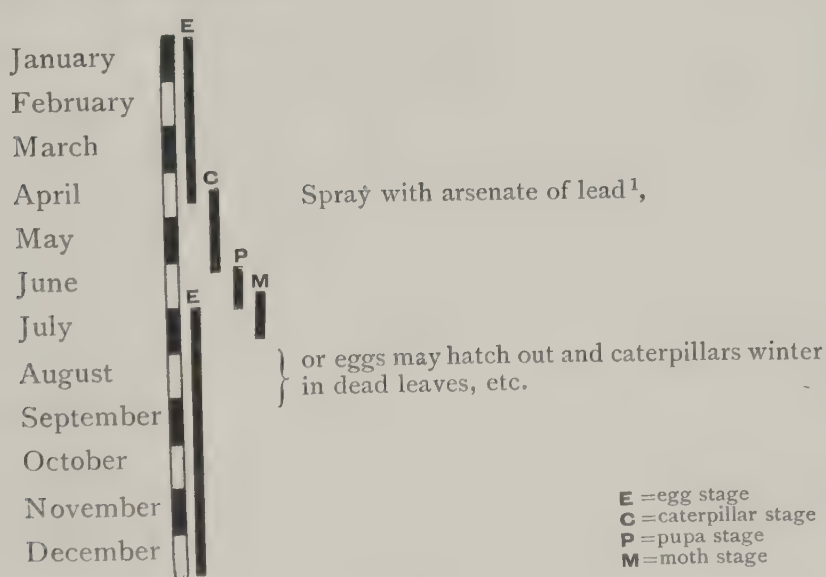
Degree of Damage

Dependent on number present: may be very serious.

Remedy

Spraying with ARSENATE OF LEAD[1], while the young caterpillars are feeding openly on the leaves before these are spun together, is the best remedy.

Calendar of Treatment



[1] See page 397.

VAPOURER MOTH

Name *Orygia antiqua* Family *Liparidæ* Order *Lepidoptera*
(*Tussock Moths*)

1. General

Description

Larva (Caterpillar)

APPEARANCE. COLOUR.	Remarkable: has four large tufts of creamy yellow and long tuft of dark hairs in front. Body dark grey spotted with red.
LOCATION.	On leaves.
APPEARS IN	Late April to May.
DURATION.	Till June or July.

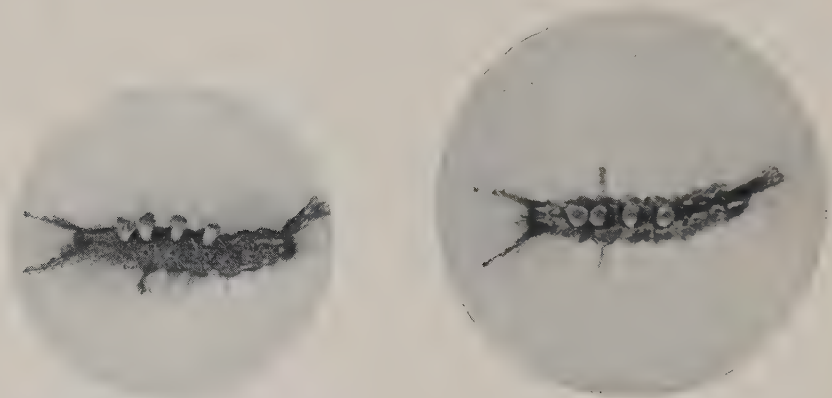


Fig. 106. Two views of Vapourer Caterpillars. Natural size.

Pupa (Chrysalis)

APPEARANCE.	In cocoons of pale silk.
COLOUR.	Brown.
LOCATION.	As for eggs.
APPEARS IN	June.
DURATION.	2 to 3 weeks.

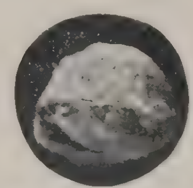


Fig. 107. Cocoon of Vapourer Moth. Natural size.

Adult Insect (Moth)

	Male	Female
SIZE ACROSS WINGS.	1 to $1\frac{1}{4}$ inches.	Almost wingless.
COLOUR (WINGS).	Chestnut brown, with white spot on each forewing.	,,
,, (BODY).	Brown.	Grey.
REMARKS.	The female is wingless like the *loopers*, but does not ascend the trunks of trees, *not moving from the pupa case.*	
APPEARS IN	Early July.	

Fig. 108. Vapourer Moths: males (above), female (below). Natural size.

Ova (Eggs)

APPEARANCE.	Conspicuous, with dark rings and central spot.
COLOUR.	Reddish brown to grey.
ARRANGEMENT.	Close, single-layered mass *on cocoon.*
LOCATION.	On the cocoons on twigs, stems, etc. or on fences near trees.
APPEAR IN	July.
HATCHING PERIOD.	Throughout winter till following May.

Distribution

Widespread over Europe.

Life-history

The adults emerge from the cocoons from early July to September. The female is wingless and remains on the cocoon, on which, after fertilisation by the winged male, she deposits her eggs.

The male flies by day with a rapid motion (especially on sunny days). The eggs remain as conspicuous objects on the cocoon, and hatch out from the end of April to the beginning of June.

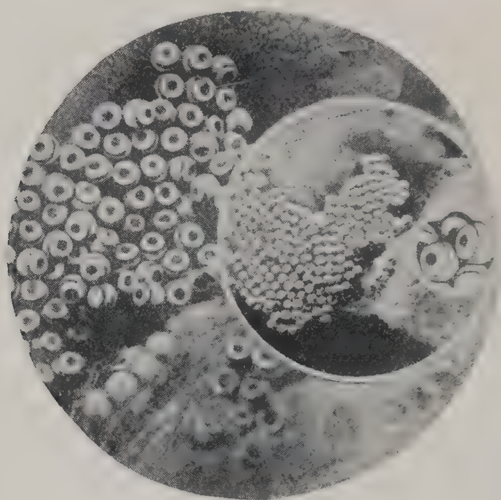


Fig. 109. Eggs of Vapourer Moth. Magnified (× 3). Inset, natural size and further enlarged (× 5).

The caterpillars are very curious and pretty, and feed on the leaves of the trees, pupating in a silken cocoon mixed with hairs from the tufts.

Remarks

Common in towns (e.g. London) as well as in the country.

2. Economic

Trees Attacked

Apples, pears, plums, damsons, walnuts, also the hawthorn, rose, sloe, acacia, elm, lime.

Frequency of Pest

Occurs locally as destructive pest at intervals.

Nature of Attack

Defoliation of the trees.

Degree of Damage

Not usually severe.

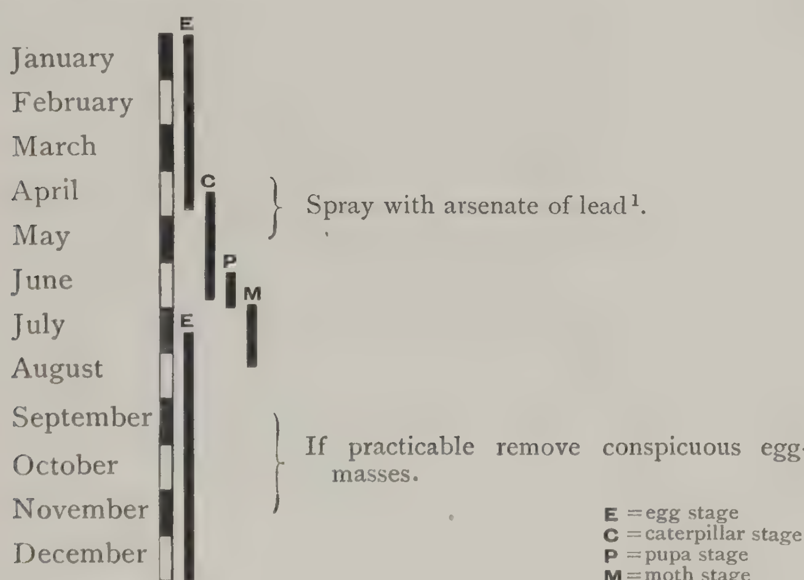
Preventive Measure

If practicable, the egg-masses, which are very noticeable, may be collected and destroyed in the winter.

Remedy

Spray with ARSENATE OF LEAD[1] as soon as the caterpillars become troublesome.

Calendar of Treatment



[1] See page 397.

WINTER MOTH

Name *Cheimatobia brumata* Class *Geometridæ* (*loopers*)
Order *Lepidoptera*

1. General

Description

Larva (Caterpillar)

APPEARANCE.	Smooth skinned; about $1\frac{1}{4}$ inches long when full fed.
COLOUR.	At first dark, then green with pale lines along body.
LOCATION.	On the leaf buds, blossom trusses, and, later, the leaves.

Fig. 110. Caterpillars of Winter Moth. Natural size.

PROGRESSION.	By *looping*.
APPEARS	Just before bursting of buds.
DURATION.	Till about middle of June.
REMARKS.	Similar to March Moth Caterpillar, but not so slender as latter.

Pupa (Chrysalis)

COLOUR.	Brown.
LOCATION.	2 to 3 inches below ground in soil under trees.
APPEARS IN	June or July.
DURATION.	Till October—January.

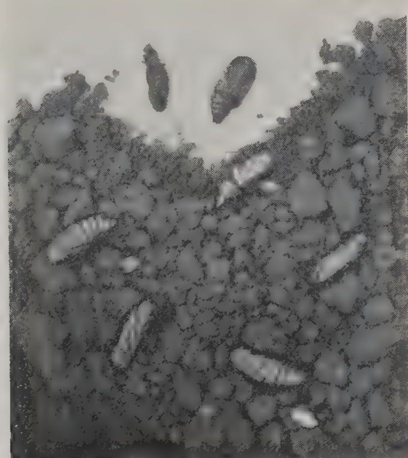


Fig. 111. Pupæ of Winter Moth in soil. Natural size.

Adult Insect (Moth)

	Male	Female
SIZE ACROSS WINGS.	About $1\frac{1}{4}$ inches.	Almost wingless.
COLOUR (WINGS).	Greyish brown to brown.	
,, (BODY).	Greyish brown.	Greyish brown.
REMARKS.	The females crawl up the tree trunks.	
APPEARS IN	October to January (variable), males some days before females.	

Ova (Eggs)

Appearance.	Small, oval, flat at ends, shells thick.
Colour.	At first, *pale yellowish green*; later *brick red.*
Arrangement.	Not systematic.
Location.	Round buds, and in crevices of twigs and boughs.
Appear in	October to January.
Hatch in	Late March or April.

Fig. 112. Winter Moth: female. Natural size.

Fig. 113. Winter Moth: female. Magnified ($\times 2\frac{1}{2}$).

Fig. 114. Winter Moth: male. Natural size.

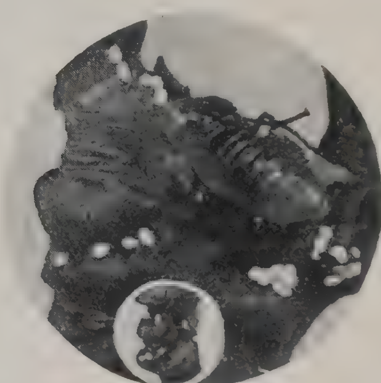


Fig. 115. Eggs of Winter Moth in position, and dead female moth. Magnified ($\times 2\frac{3}{4}$). Inset, natural size.

Distribution

Very widespread.

Life-history

The females leave the ground and crawl to the tree-trunks, which they ascend, being usually fertilised by the winged male moth during this time.

The eggs are then laid on the branches in crevices, a female laying as many as 300 eggs.

The eggs hatch out *just before the bursting of the leaf-buds* in spring and the small looper caterpillars attack the young leaves, and enter the flower trusses spinning these together. Later they feed openly on the leaves, and may attack the young fruit.

Pupation usually occurs during June, the caterpillar dropping to the ground and entering the soil. Before pupating, an oval cocoon of silk is usually spun, and a small cavity in the soil chosen.

Remarks

1. The males are seen to fly at dusk just before the females ascend the trees.
2. It is at present uncertain whether, in some few cases, the males do not fly with the females (*in copula*) to the branches. In any case, it is not a common practice, as is shown by the large number of females caught upon the sticky bands.

2. Economic

Trees Attacked

Apples, plums. Many forest trees attacked.

Susceptible Varieties

All varieties open to attack.

Frequency of Pest

Very common, probably the commonest and most destructive of all caterpillar pests.

Nature of Attack

The caterpillars eat the leaves continuously from the bursting of the buds till the middle of June.

Flowers and fruit may also be attacked.

Duration of Attack

During spring and early summer.

Degree of Damage

Unless promptly dealt with, the trees may be entirely defoliated.

Preventive Measures

Turn over soil under trees and keep fowls in orchard—many pupæ may thus be destroyed.

Remedies

1. Applying grease-proof paper-bands to the trunks of the trees and coating with BANDING COMPOSITION[1] to catch the ascending female moths and so prevent egg laying.
2. Spraying the trees with ARSENATE OF LEAD[2] when the attack first appears, or subsequently.

   The eggs are too resistant to be successfully dealt with by winter washes, despite many interested statements to the contrary.
3. Applying a thick LIME and SALT[3] cover-wash to the trees in late winter to seal the eggs and hinder their hatching.

Remarks on Remedies

The life-history of the Winter Moth offers peculiar opportunities to the grower for successful treatment of this pest.

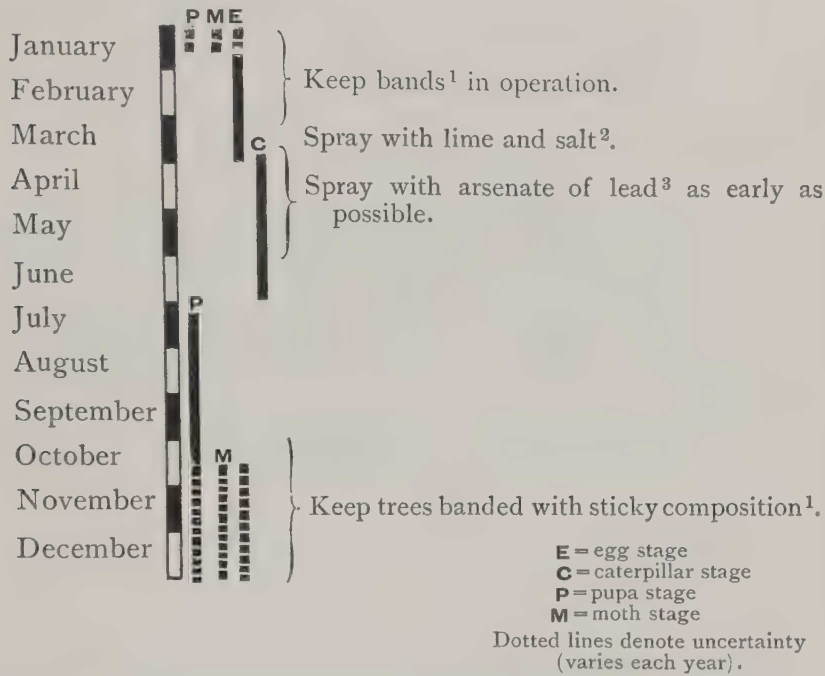
The females, being wingless, are obliged to crawl up the trunks of the trees to gain the branches. If therefore the trunks are properly banded (see method of banding, page 406) and the bands kept in efficient operation during the whole time when the moths appear, all egg laying should be prevented[4] (see however Remarks, 2 on page 179). The bands

[1] See page 404. [2] See page 397. [3] See page 428.

[4] As many as 300 female Winter Moths have been caught on a single band!

should be in operation before the end of September and kept sticky till the spring (for March Moth).

Calendar of Treatment



WOOD LEOPARD MOTH

Name *Zeuzera pyrina* Family *Coccidæ* Order *Lepidoptera*

1. General

Description

Larva (Caterpillar)

APPEARANCE.	Each segment with a black bristle. About 2 inches long.
COLOUR.	Yellowish white: head brown, with two black spots.
LOCATION.	In tunnels in the wood of trees.
APPEARS IN	June to August.
DURATION.	10 months.

[1] See page 404. [2] See page 428. [3] See page 397.

Pupa (Chrysalis)

APPEARANCE.	In silken cocoon mixed with particles of wood.
COLOUR.	Bright brown.
LOCATION.	Under the bark.
APPEARS IN	May.
DURATION.	Few weeks.

Fig. 116. Diagram of branch opened to show Caterpillar of Wood Leopard Moth. Natural size.

Fig. 117. Wood Leopard Moth: wings folded and open. Natural size.

Adult Insect (Moth)

SIZE ACROSS WINGS.	About 2 inches (female larger than male).
COLOUR (WINGS).	White, with spots of steel-blue.
,, (BODY).	Head covered with downy white; abdomen bluish black.
APPEARS IN	June and July.

Ova (Eggs)

COLOUR.	Dark or orange-yellow.
LOCATION.	Deep in the bark of trees.
APPEAR IN	June to August.
HATCHING PERIOD.	Few days.

Distribution

General over Europe.

Life-history

The very striking moths may be seen resting near the ground on tree trunks.

The eggs are laid deep down in the bark of the trees by the powerful egg-depositor of the female. These eggs hatch out in a few days and the young caterpillars bore their way into the wood of the tree, remaining inside the branch and tunnelling through it till mature in about 10 months.

They then pupate near the surface, the brown pupa giving rise in a few weeks to the mature moth, which makes its escape from the tree.

2. Economic

Trees Attacked

Apples, cherries, pears, chestnuts.

Frequency of Pest

Not frequent.

Nature of Attack

The caterpillars, by tunnelling through the wood of the branches, finally cause the death of the latter.

Degree of Damage

Usually serious on attacked trees.

Remedies

1. If holes are found, CARBON BISULPHIDE[1] vapour may be blown into the aperture by means of bellows, or
2. A piece of CYANIDE OF POTASH[2] (*caution, poison*) may be placed in the hole and then this plugged up with clay.
3. When branches are obviously dying and no holes can be seen, slit them up till the caterpillar is found and kill it.

Calendar of Treatment

[Remedies: see above.]

E = egg stage
C = caterpillar stage
P = pupa stage
M = moth stage

[1] See page 410. [2] See page 423.

BEETLES

(*COLEOPTERA*)

and their larvæ (GRUBS)

CHAPTER 13

Beetles

(COLEOPTERA)

1. General

Most of the beetle pests of fruit trees are destructive in the adult or *beetle* stage. In the case however of two of the weevils, it is the grub only which does the damage, the adult beetle not feeding on the leaves to any serious extent, if at all. In the remainder of the beetle pests, both adults and grubs are injurious. They may therefore be classed as follows:

GRUB ONLY INJURIOUS	ADULT BEETLE ONLY INJURIOUS	BOTH GRUBS AND BEETLES INJURIOUS
Apple-blossom weevil	Leaf weevils	Raspberry weevil
Nut weevil	Red-legged weevil	Fruit-bark beetle
	Twig-cutting weevil	Raspberry beetle
	Ground beetles	Shot-borer beetle
		Cockchafer
		Rosechafer

Of all fruits perhaps raspberries are most seriously attacked by beetles of different kinds. The APPLE-BLOSSOM WEEVIL however is one of the worst pests of apples, and is apparently on the increase.

The methods of dealing with beetle attacks are much less satisfactory than in the case of caterpillars. Those weevils which lay their eggs inside the blossom cannot be killed with a stomach poison, such as arsenate of lead, as they do not appear to feed. A good coating of lime prevents the laying of the egg in the blossom and research is in progress on the lines of making the blossoms distasteful to the weevils by means of some chemical substance.

In the case of many beetles, the most generally successful method consists in catching the adults by jarring them on to tarred boards, but this is a laborious and tedious business.

A few which actually devour the leaves or blossoms may be successfully dealt with by spraying with arsenate of lead.

The two beetles which attack the trunks of trees, and feed internally —the Fruit-bark and Shot-borer beetles—present, so far, an unsolved problem. The only remedy is to cut down and destroy the trees and so prevent the spread of the pest.

The grubs of beetles attacking the roots of plants are dealt with by treating the ground with soil insecticides.

It should be remembered, in this connection, that all beetle grubs found in the soil are not injurious; many are on the contrary actually beneficial, living upon other insect life, especially snails, etc.

2. Scientific

Beetles have a strong armour-plate of chitinous material, which is a protection to insects which are often under the soil. The legs are strong, and the hind-wings very large and folded beneath the *elytra* or hardened fore-wings which act as cases or shields. The mouth is adapted for chewing.

All beetles undergo a complete transformation, having a true *pupal* resting stage.

The colour varies. Beetles living underground are dark in colour; others may be brown, and leaf-eating weevils are often green.

Larvæ which burrow in the ground, or in trees, may feed two or three years before reaching maturity. In contrast to this, the apple-blossom weevil goes through its whole life-history in a few weeks.

The beetle grubs may be footless, and resemble maggots, as in the case of many weevils, or they may have three pairs of legs. In chafers the legs are short, and the skin fleshy.

Classification.

Order **COLEOPTERA**

Sub-order 1. LAMELLICORNIA.

Only one family are fruit pests, viz:

Scarabæidæ (chafers).

Cockchafer, *Melolontha vulgaris*.

Rose chafer, *Cetonia aurata*.

Sub-order 2. ADEPHAGA (predatory beetles).

Nearly all this group are beneficial, eating other insects. A few of the ground beetles sometimes attack plants.

Carabidæ (ground beetles).

Occasionally pests.

Sub-order 3. CLAVICORNIA.

Practically all these beetles are beneficial, being insect eaters. The most directly beneficial are the family

Coccinellidæ (lady-birds).

These and their larvæ devour aphides greedily (see page 469).

Sub-order 4. SERRICORNIA.

None of these beetles appear to attack fruit.

Sub-order 5. HETEROMERA.

Remarks as for (4).

Sub-order 6. PHYTOPHAGA (leaf-eating beetles).

Most of these are pests on various plants.

Raspberry beetle, *Byturus tomentosus*.

Sub-order 7. RHYNCHOPHORA (snout-beetles).

Head with snout and mouth parts at end.

Family *Curculionidæ* (weevils).

Antennæ, elbowed.

Apple-blossom weevil, *Anthonomus pomorum*.
Nut weevil, *Balaninus nucum*.
Raspberry weevil, *Otiorhyncus picipes*.
Red-legged weevil, *Otiorhyncus tenebricosus*.
Twig-cutting weevil, *Rhynchites cæruleus*.
Leaf weevils, *Phyllobius*, various species.

Family *Scolytidæ*.

Snout short: antennæ clubbed, not usually elbowed.

Fruit-bark beetle, *Scolytus rugulosus*.
Shot-borer beetle, *Xyleborus dispar*.

CHAPTER 14

Weevils

APPLE-BLOSSOM WEEVIL

Name *Anthonomus pomorum* Class *Rhynchophora* (*Weevils*)
Order *Coleoptera* (*Beetles*)

1. General

Description

Adult Insect (Weevil)

SIZE.	Small (about $\frac{1}{8}$ to $\frac{1}{6}$ inch long).
COLOUR.	Brownish black, with pale **V**-shaped mark on wing-cases.
APPEARS IN	Early April (old brood), May—June (new brood).
DURATION.	Throughout summer, autumn, winter and early spring.
REMARKS.	The snout long, slender and curved, with feelers (antennæ) near the end, in two segments at right angles.

Ova (Eggs)

APPEARANCE.	Small, oval.
COLOUR.	White.
ARRANGEMENT.	Laid singly.
LOCATION.	In the centre of blossom bud.
APPEAR IN	April.
HATCHES IN	5 to 7 days.

Larva (Grub)

APPEARANCE.	Small, legless (about $\frac{3}{16}$ inch when mature).
COLOUR.	White with dark brown head and brown spiracles.
LOCATION.	Curved up inside blossom bud.
APPEARS IN	April and May.
DURATION.	1 to 3 weeks.
REMARKS.	The length of the larval period depends upon weather conditions.

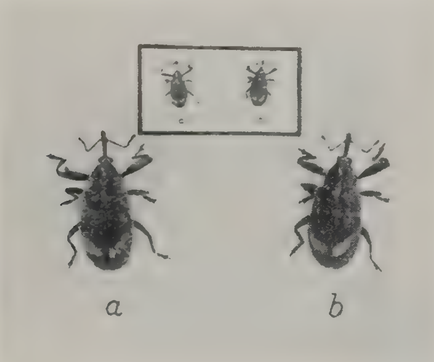


Fig. 118. Two specimens of Apple-Blossom Weevil. Magnified (× 3). Inset, natural size.

Pupa (Chrysalis)

APPEARANCE.	With long snout folded under head.
COLOUR.	Pale brown—eyes black.
LOCATION.	In dying or dead blossom buds.
DURATION.	7 to 10 days.

Distribution

Widespread.

Life-history

The adult weevils come out from their winter hiding-places on the arrival of the first warm days of spring. The females are winged, but usually prefer to crawl up the trees. The

males are often seen flying among the branches in sunny weather in search of the females, which must be fertilised before egg-laying takes place.

The actual process of the egg-laying is very curious and ingenious. The female first takes considerable trouble in selecting the blossom-bud. By means of her long snout, she then bores a deep hole reaching to the centre of the bud, where she produces a small cavity. She then lays an egg in the hole and pushes this down the channel so formed till it

Fig. 119. Diagram of grub and pupa of Apple-Blossom Weevil. Natural size and enlarged. Also of capped blossom.

reaches the cavity in the centre. Finally the entrance is sealed up with saliva, and the insect proceeds to attack another bud in a similar manner. A single female can lay 20 to 60 eggs in as many blossoms, providing these do not expand too rapidly.

The egg hatches out in a few days to a small white legless grub with a brown head, which feeds upon the unopened bud for 1 to 3 weeks, changing finally into a pale, yellowish-brown pupa, with a long snout (proboscis) folded under the head.

The blossom is now practically dead ("capped"), and in a few days the mature weevil emerges, leaving a large round hole in the base of the blossom. It feeds for the rest of the summer upon the leaves of the apple, and, in the autumn,

Fig. 120. View of "capped blossom" caused by the Apple-Blossom Weevil.

seeks out shelter in crevices on the bark, or under rubbish. Here the winter is spent. Many of the weevils fly to other trees to seek their sheltering-places and return to the apples in the spring.

2. Economic

Trees Attacked

Apples, and occasionally pears.

Frequency of Pest

Common.

Nature of Attack

The attacked blossom withers (becomes "capped"), the bud never opening, and the petals soon withering, but remaining on the tree till later. The attack on the leaves by the weevils is not serious.

Fig. 121. As fig. 120, but "cap" removed to show pupa within.

Degree of Damage

This depends almost entirely upon the weather conditions. If, after blossoming, a cold spell intervenes, and the blossoms are prevented from rapidly expanding, a great many may be attacked. The grub cannot live in an opened blossom and many eggs are in this way rendered harmless by the expansion of the flower buds before they are hatched.

Natural Enemies

Woodpeckers, tits, and certain parasitic flies (ichneumons).

Preventive Measures

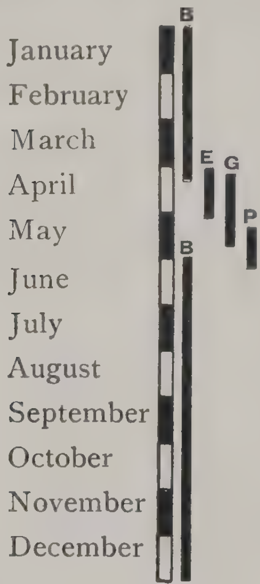
1. When blossoms are noticed unopened, and brown at the tips, the tree should be shaken. These will then readily fall, and may be collected and burnt, as they will contain either the grub or the pupa of the weevil. This treatment will lessen a future attack.
2. Later on the weevils may be jarred off on to boards, covered with tar or banding composition. A suitable surface is also made by covering a light frame of wood, say 6 feet square, with tarred canvas, and holding amongst the branches by means of a long wooden handle, whilst jarring the tree.

Remedies

1. The most effective remedy at present known is to keep the opening buds covered with THICK LIME WASH (see page 428). This may be continued right up to the appearance of the blossom trusses (see fig. 244, page 616). The weevil is thus prevented from laying its egg in the bud.
2. Poison sprays, such as arsenate of lead, have not been found of much use, as it is probable that the weevil eats only a minute portion of the surface of the bud when laying the egg.
3. SOAP[1] sprays with NICOTINE[2] have been found of more service *if the weevils are actually on the trees*, which is difficult to ascertain.
4. The author has found *distinct benefit* resulting from a late LIME-SULPHUR[3] spray, just before the blossom-buds are commencing to open. A little scorching of the leaves and petals resulted, but this had no injurious effect, as the *stamens*[4] were not reached by the spray. The presence of the lime-sulphur probably rendered the blossoms distasteful to the weevil.

[1] See page 452. [2] See page 436.
[3] See page 612. [4] See page 21.

Calendar of Treatment



Covering buds with thick lime wash found effective[1]; to a less extent soap[2] and nicotine[3]; and late lime-sulphur spraying[4].
Shake off and burn the withered buds.
Jar weevils off on to tarred boards.

B = beetle stage
E = egg stage
G = grub stage
P = pupa stage

LEAF WEEVILS ("Oblong," "Green" etc.)

Names *Phyllobius, various species* Class *Rhynchophora* (*Weevils*) Order *Coleoptera* (*Beetles*)

1. General

Description

Adult Insect (Weevil)

SIZE.	Small, $\frac{1}{6}$ to $\frac{1}{5}$ inch.
COLOUR.	Oblong—black with brown scales. Green—brown, with bright green to yellow scales.
APPEARS IN	May.
DURATION.	Till July.

Ova (Eggs)

LOCATION.	In the ground.
APPEAR IN	June and July.

[1] See page 428. [2] See page 452.
[3] See page 436. [4] See page 612.

Larva (Grub)

APPEARANCE.	Footless, with a few hairs; curved.
COLOUR.	White with brown head.
LOCATION.	In soil.
APPEARS IN	June and July.
DURATION.	Throughout winter till following spring.
REMARKS.	The maggots live upon roots of plants.

Pupa (Chrysalis)

LOCATION.	In soil.
APPEARS IN	April.

Fig. 122. Diagram of Oblong Leaf Weevil. Natural size and magnified.

Life-history

These leaf weevils appear from the soil in late spring and attack the opening flower buds, later feeding upon the leaves. They lay their eggs in the soil and the grub lives there till the spring when it pupates.

2. Economic

Trees Attacked

Pear, apple, plum, apricot, peach, strawberry.

Susceptible Varieties

Grafted plants (Ormerod).

Frequency of Pest

Occurs in large numbers locally.

Nature of Attack

The blossom-buds and later the leaves are gnawed away by the weevil. Sometimes the roots are also attacked by the grubs.

Degree of Damage

Often serious.

Remedies

1. Jar the weevils off the trees on a dull day placing tarred boards beneath, or band the trees with COMPOSITION[1] and prevent the weevils regaining the leaves.

[1] See page 404.

2. Spray the leaves and buds with ARSENATE OF LEAD[1], especially if there is also caterpillar attack.

Calendar of Treatment

As for *Raspberry Weevil* (see page 205).

NUT WEEVIL

Name *Balaninus nucum* Class *Rhynchophora* (*Weevils*)
Order *Coleoptera* (*Beetles*)

1. General

Description

Adult Insect (Weevil)

SIZE.	About $\frac{1}{3}$ inch long.
APPEARANCE.	With *long curved snout.*
COLOUR.	Variable—tawny brown covered with yellowish or greyish down.
APPEARS IN	June.
REMARKS.	Distinguished by its characteristic snout.

Ova (Eggs)

ARRANGEMENT.	Singly in interior of nut.
HATCH IN	8 to 10 days.

Larva (Grub)

APPEARANCE.	Legless, fat and fleshy, and curved at tail end, about $\frac{1}{3}$ inch long.
COLOUR.	Cream coloured.
LOCATION.	Inside kernel of nut till mature, afterwards in the ground.
APPEARS IN	July and August.
DURATION.	Throughout winter (in soil) till following spring.

[1] See page 397.

Pupa (Chrysalis)

Colour.	Creamy white.
Location.	In ground.
Appears in	March and April.
Duration.	Till late May or June (variable).

Distribution

Widespread and common.

Fig. 123. Diagram of various stages of Nut Weevil, natural size and enlarged, also damaged nut.

Life-history

The weevil bores a hole in the soft young nut with her long curved snout, deposits one egg in the hole formed, and then pushes it into the centre of the nut. In a few days the grub appears and lives on the flesh of the kernel till mature. Sometimes the nut drops and at others remains on the tree. In any case the mature caterpillar forces its way out of the nut and winters in the ground in an inactive condition, pupating the following spring.

2. Economic

Trees Attacked

Nuts (filberts, cobs, wild hazels).

Frequency of Pest

Common.

Fig. 124. Grub of Nut Weevil and holes caused by incision of the adult insect. Natural size.

Nature of Attack

The kernel of the nut is eaten and spoilt by the grub. (The well-known "maggotty nuts.")

Degree of Damage

Often serious.

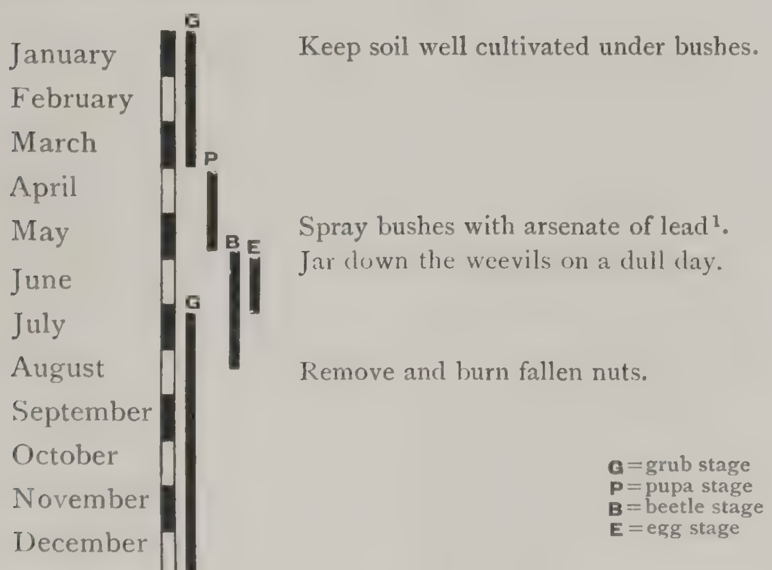
Preventive Measures

1. Remove and burn all nuts which fall before they are ripe (as these contain live grubs).
2. Frequent stirring of the soil under the bushes during the winter exposes the tender grubs to frost and birds.

Remedies

1. Choose a DULL day, and beat the trees, after placing tarred boards or sacks underneath, or giving the surface of the ground a good sprinkling of gas-lime.
2. Spraying the bushes in late May with ARSENATE OF LEAD[1] has been found effective.

Calendar of Treatment



[1] See page 397.

RASPBERRY (CLAY-COLOURED) WEEVIL

Name *Otiorhyncus picipes* Class *Rhynchophora* (*Weevils*)
Order *Coleoptera* (*Beetles*)

1. General

Description

Adult Insect (Weevil)

SIZE.	$\frac{1}{4}$ to $\frac{1}{3}$ inch. No wings.
COLOUR.	Brown, covered with patches of brown or grey scales, giving it an *appearance of mottled clay*.
APPEARS IN	May.
REMARKS	This weevil feeds at night and hides during the day-time. It falls to the ground on being the least disturbed, or with a light. It is extremely difficult to distinguish on the ground as it remains quite motionless after falling.

Ova (Eggs)

LOCATION.	Just under the ground.
APPEAR IN	August.
HATCH IN	Few days.

Larva (Grub)

APPEARANCE.	Dull, footless, skin much wrinkled: head brown.
COLOUR.	Yellowish white.
LOCATION.	In the ground.
APPEARS IN	August.

DURATION.	Throughout winter till following April.
REMARKS.	The maggot feeds upon the roots of the plant attacked.

Pupa (Chrysalis)

APPEARANCE.	Like weevils in shape, but with legs folded beneath.
COLOUR.	Yellowish white.
LOCATION.	In the ground; near surface.
APPEARS IN	About April.
DURATION.	2 to 3 weeks.

Fig. 125. Diagram of grub and adult of Raspberry Weevil. Natural size and enlarged.

Distribution

Widespread. Destructive epidemics of it have been reported at various times in almost all the fruit-growing districts of England.

Life-history

The weevils appear from the ground in May. They are unable to fly, being without wings, and protect themselves by dropping to the ground on the least noise or disturbance, and

so escaping detection by their close resemblance to the earth. They feed at night upon the young blossoms and leaves, and also attack the shoots, stripping the rind off and puncturing the tender parts with their snouts.

In August the eggs are laid just under the ground, and the footless grubs which hatch out feed upon the roots of the plant throughout the winter, changing in April to inactive pupæ which give rise to the weevils in due course.

2. Economic

Fruit-Plants Attacked

Raspberry mainly: also gooseberry, hop, plum, apple, damson, nuts, strawberry.

Frequency of Pest

Common.

Symptoms of Attack

Young leaves appear with small holes, shoots are damaged.

Nature of Attack

The weevils attack the young fruit buds and the blossoms. They also eat the leaves, and puncture or skin the shoots. The grubs attack the roots during the winter months.

Duration of Attack

Weevil—April to August.
Grub—throughout winter.

Degree of Damage

Often extremely serious, especially when the blossom and buds are attacked.

Preventive Measures

1. Remove weeds and rubbish from the plots.
2. Hoe in the usual SOIL INSECTICIDES[1] during the autumn to kill the grubs.

[1] See page 433.

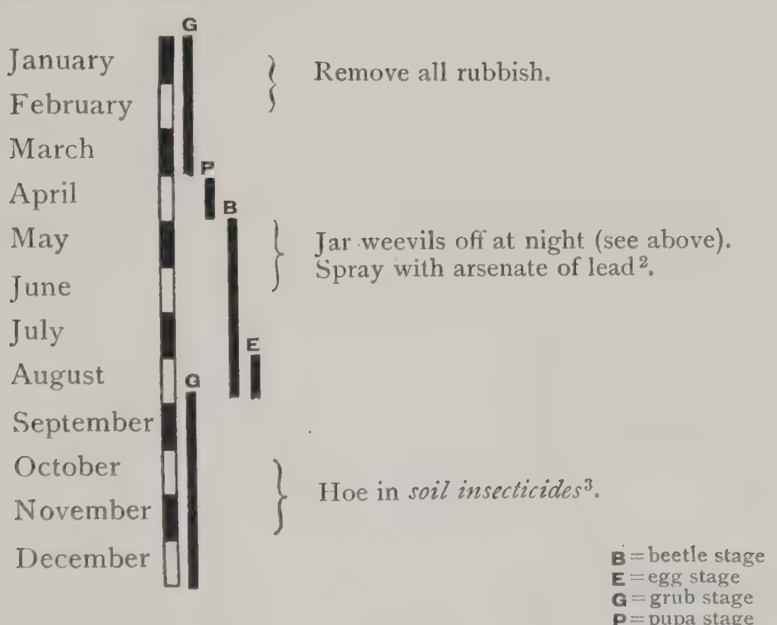
Natural Enemies

Moles, tits, and some wasp-like flies (*Cerceris*).

Remedies

1. This weevil is very easily dealt with by making use of its extremely timid habits.
   Provide boards smeared over with BANDING COMPOSITION[1], or sticky tar, and proceed *quietly* to the plantation *after dark*. Take a lantern, but be careful to keep its rays from the plants, or no good will result. Hold the boards on each side of the canes (if raspberries) or under the plants, then jar them or flash the light. The weevils will thus be readily caught.
2. Spray the plants well, as soon as the attack is noticed, with ARSENATE OF LEAD[2]. This is an almost certain cure as the weevils soon get a fatal dose of the poison.

Calendar of Treatment



[1] See page 404. [2] See page 397. [3] See page 433.

RED-LEGGED WEEVIL

Name *Otiorhyncus tenebricosus* Class *Rhynchophora* (*Weevils*)
Order *Coleoptera* (*Beetles*)

1. General

Description

Adult Insect (Weevil)

Size.	About ½ inch long.
Colour (body).	Shiny black—*legs dull red.*
Appears in	May and June.
Remarks.	The weevil feeds at night and hides away during the day.

Ova (Eggs)

Location.	In ground.
Appear in	June and July.

Larva (Grub)

Appearance.	Similar to the preceding species (clay-coloured weevil) but larger.
Colour.	Yellowish white.
Location.	In the ground.
Appears in	August.
Duration.	Throughout the winter till following April.

Pupa (Chrysalis)

Appearance.	As for clay-coloured weevil, but larger.
Colour.	Yellowish white.
Location.	In the ground, near surface.
Appears	About April.
Duration.	2 to 3 weeks.

Distribution

Widespread. Appears suddenly as a pest at various places.

Life-history

As for clay-coloured weevil (see page 203).

2. Economic

Trees Attacked

Most fruit, especially plum and raspberry.

Nature of Attack

The weevil attacks the buds and young shoots, and later on feeds upon the leaves.

Fig. 126. Diagram of Red-legged Weevil. Natural size and enlarged.

Degree of Damage

Often very serious.

Preventive Measures, Remedies and Calendar of Treatment

As for clay-coloured weevil.

TWIG-CUTTING WEEVIL

Name *Rhynchites cœruleus* Class *Rhynchophora* (*Weevils*)
Order *Coleoptera* (*Beetles*)

1. General

Description

Adult Insect (Weevil)

SIZE.	About $\frac{1}{8}$ inch long.
COLOUR.	Shiny blue ; snout and legs black.
LOCATION.	On leaves.

APPEARS IN	April and May.
REMARKS.	After laying her egg in the shoot, the female severs this just below the puncture, causing the shoot to die and fall to the ground.

Ova (Eggs)

APPEARANCE.	Oval.
COLOUR.	Yellow.
ARRANGEMENT.	Singly placed.
LOCATION.	In shoot.
HATCH IN	7 to 10 days.

Fig. 127. Diagram of Twig-cutting Weevil. Natural size and enlarged.

Larva (Grub)

APPEARANCE.	Footless, small.
COLOUR.	White.
LOCATION.	In pith of shoot.

Pupa (Chrysalis)

LOCATION.	In ground.
DURATION.	Probably till following spring.

Distribution

Noticed chiefly in Kent.

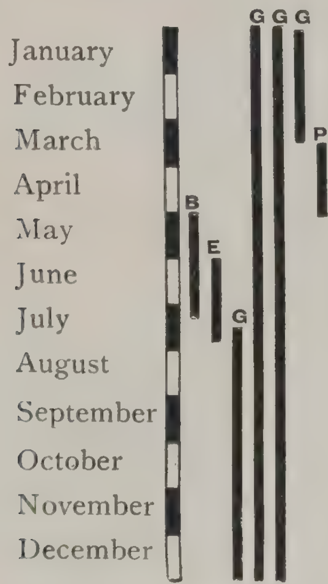
Life-history

The weevils appear on the leaves early in the season, but seem to do little damage. After fertilisation, the female punctures a shoot

Remedies

1. Jarring the sluggish beetles during the daytime on to tarred boards, or into bags, is very effective.
2. Mixing SOIL INSECTICIDES[1] with the earth around the roots will kill the grubs.
3. Spraying the plants with ARSENATE OF LEAD[2] will kill the beetles devouring the foliage.

Calendar of Treatment



Jar off beetles on to tarred boards or spray with *arsenate of lead*[2].

Mix *soil insecticides*[1] into earth around plants.

B = beetle stage
E = egg stage
G = grub stage
P = pupa stage

[1] See page 433. [2] See page 397.

ROSE CHAFER (Green chafer)

Name *Cetonia aurata* Class *Lamellicornia* (*Chafers*)
Order *Coleoptera* (*Beetles*)

1. General

Description

Adult Insect (Beetle)

SIZE.	About $\frac{3}{4}$ inch long.
COLOUR (BODY).	Brilliant metallic green; has a golden sheen in sunlight. Coppery below.
APPEARS IN	May or later.
REMARKS.	The beetles fly on sunny days.

Ova (Eggs)

LOCATION.	Fairly deep in the soil.
APPEAR IN	July and August.
HATCHING PERIOD.	12 to 14 days.

Larva (Grub)

APPEARANCE.	Thick, fleshy, wrinkled; tail-end much swollen (full-grown = $1\frac{1}{2}$ inches long).
COLOUR.	Yellowish white; a brown spot on each side of first segment.
LOCATION.	In the soil.
APPEARS IN	July and August.
DURATION.	*2 to 3 years.*
REMARKS.	Resembles the Cockchafer grub, but distinguished from this by the short hairs on the body and legs, and the pointed feet.

Pupa (Chrysalis)

APPEARANCE.	In a case of stones, earth etc. (about $\frac{3}{5}$ inch long).
COLOUR.	Whitish yellow, eyes dark.
LOCATION.	Some distance below the surface of the ground.
APPEARS IN	June or earlier.

Life-history

These very fine beetles appear on fine summer days flying amongst the foliage, and feeding upon the leaves and blossom. The eggs are laid in the ground and the grubs pass 2 to 3 years in the soil before they are mature, living upon roots of plants or on decaying vegetable matter. They pupate in a case formed of stones, earth, etc., glued together by a secretion from the insect's body.

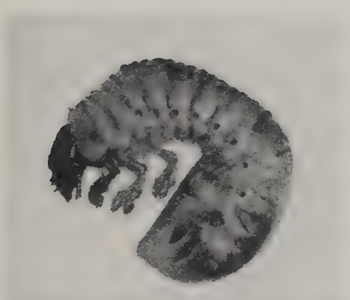


Fig. 137. Rose Chafer. Larva. Natural size.

Fig. 138. Diagram of larva, pupa and adult of Rose Chafer. Natural size.

2. Economic

Trees Attacked

Apple, raspberry, currant, pear, etc., also roses, etc.

Frequency of Pest

Fairly common.

Nature of Attack

1. The beetle ravenously devours the blossoms and leaves.
2. The grub eats and cuts the roots of plants, often causing these to wilt and die.

Degree of Damage

Serious, if the beetle appears in any numbers.

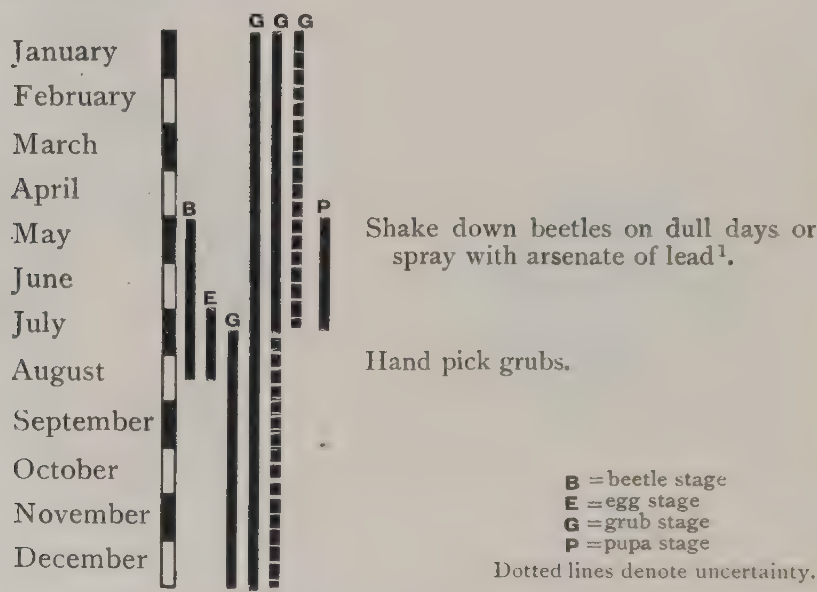
Preventive Measures

1. Sods, placed grass-side downwards on the ground, will attract the grubs, which can then be destroyed.
2. Hand picking the grubs after deeply forking about the roots of the attacked plants is advisable.

Remedies

1. Shake the beetles off the trees and bushes in dull weather.
2. Spray the plants with ARSENATE OF LEAD[1] when the beetles first appear.

Calendar of Treatment



[1] See page 397.

FLIES

SAWFLIES (*HYMENOPTERA*)

TWO-WINGED FLIES (*DIPTERA*)

CHAPTER 16

Flies
(HYMENOPTERA and DIPTERA)

1. General

All the pests belonging to these groups are harmful in the maggot (larva) stage only. The adult insects do not injure the fruit.

The injury is of two kinds:

INJURY TO THE LEAVES (mainly).

Gooseberry and Currant sawfly.
Slug worm.
Nut sawfly.
Plum leaf sawfly.
Social Pear sawfly.

INJURY TO THE FRUIT.

Apple sawfly.
Plum fruit sawfly.
Pear midge.

With the exception of the curious *slug worm* the larvæ which feed upon the leaves strongly resemble the caterpillars (Lepidoptera). They can, however, be readily distinguished from these by the number of "sucker feet" (*prolegs*). All caterpillars have *four* of these in the middle of the body (except the *Geometridæ*) while the sawfly larvæ have more than this number, e.g. the Apple sawfly larva has six.

The remedy for these is a stomach poison, as for caterpillar. Arsenate of lead is efficient, but is generally dangerous to use when the fruit is forming, especially in the case of small fruit, as gooseberry, currant, etc. Comparatively non-poisonous insecticides are however available, e.g. Hellebore and Pyrethrum, and are admirably suited for this purpose.

With regard to the maggots of the Apple sawfly and Pear midge, which are hatched and live protected inside the fruitlet, there is no

satisfactory remedy. It is at present only possible to mitigate the pest by picking off the attacked fruit and so prevent further damage.

In the case of the Plum fruit sawfly, an early spraying of the blossom with arsenate of lead is of proved value, since the maggot is somewhat exposed in its early stages.

Fig. 139. Apple Sawfly Maggot entering young fruit.
Natural size.

The ichneumon flies, which are highly beneficial insects, destroying annually vast numbers of injurious insects, belong to this group. These are elsewhere described[1].

[1] See page 471.

2. Scientific

The *Sawfly larvæ* differ very much. They may be naked, or hairy, and the fruit eaters resemble maggots in form, being pale and fleshy. The mature insect resembles the bees and wasps (which are the higher members of this order) in having two pairs of membranous wings.

They are remarkable for the cutting instruments, possessed by the females, which strongly resemble saws in shape. These are employed for making incisions in the tissues of plants for the purpose of inserting the eggs in a safe situation.

The *Pear midge* belongs to a different order (Diptera). It is a two-winged fly belonging to the gall-fly group. In this order there are also a large number of beneficial insects, the maggots of which live inside the bodies of many insect pests, especially caterpillars. These are referred to in a later chapter[1].

Classification

Order **Hymenoptera**

There is a full series of transformations from egg to adult insect, and a definite pupal stage. There are two pairs of membranous wings. Most of the females possess *ovipositors* for placing the eggs in suitable positions. These are also often provided with a saw, a borer, or a sting.

Of the three sub-orders, only the first has members which are of injury to fruit. The other two contain a large number of beneficial insects, viz. those which are parasitic on insect pests and the bees and wasps, which assist fertilisation of the flowers.

Sub-order 1. SESSILIVENTRES.

Family *Siricidæ* (wood wasps).

No pests.

Family *Tenthredinidæ* (sawflies).

The female furnished with a pair of saws, for egg-laying. The pests include:

Apple sawfly, *Hoplocampa testudinea.*
Gooseberry and Currant sawfly, *Nematus ribesii.*
Slug worm, *Eriocampa limacina.*
Nut sawfly, *Crœsus septentrionalis.*
Plum fruit sawfly, *Hoplocampa fulvicornis.*
Plum leaf sawfly, *Cladius padi.*
Social Pear sawfly, *Pamphilus flaviventris.*

[1] See Section VI, page 465.

Sub-order 2. PARASITICA.

Most of these are parasites, many of them on destructive caterpillars and pupæ, and others on aphis, etc. (see page 465).

Family *Cynipidæ* (gall flies).

Family *Proctotrypidæ*.

Many of these are parasites on insects.

Family *Chalcididæ*.

The females of this family are winged and the males wingless—a very curious feature.

Family *Ichneumonidæ* (the ichneumon flies).

About all parasitic on insects.

Family *Braconidæ*.

Mostly parasitic.

Sub-order 3. ACULEATA.

Family *Chrysididæ* (ruby wasps).

Family *Apidæ* (bees).

Friendly insects of great value as fertilising agents.

Family *Fossores* (digging-wasps).

Family *Diploptera* (true wasps).

Occasionally pests on ripe fruit, but mainly beneficial insects.

Family *Formicidæ* (ants).

Probably unfriendly to the extent of their care and culture of aphis pests.

Order **Diptera**

Of this large order of insects, only the PEAR MIDGE, *Diplosis pyrivora*, is a destructive pest on fruit. The *Tachina* flies are parasitic on caterpillars. They do not puncture the skin, but lay the eggs on the surface. The larvæ then bore their way into the caterpillar.

Sub-order 1. NEMOCERA.

The gall midges belong to this group. The only pest is the Pear Midge, *Diplosis pyrivora*.

Sub-order 2. BRACHYCERA.

Horse flies and Gadflies are in this group.

The Robber flies kill and suck insects of all kinds and are beneficial.

Sub-order 3. ATHERICERA.

This includes three large families.

Family *Syrphidæ*.

Many resemble bees and wasps, and are useful as agents in fertilisation of flowers. Some of the larvæ devour aphides.

Fig. 140. Gooseberry Sawfly mounted and magnified, showing especially mouth parts and saws (at end of body).

Fig. 141. Gooseberry and Currant Sawfly, enlarged. Inset, natural size. Showing the six prolegs.

Family *Muscidæ.*

An enormous family, all more or less resembling the house-fly. The *Tachina flies* are beneficial parasites of insects. Other groups are destructive to vegetable crops.

Family *Estridæ.*

This includes the *Bot flies* the larvæ of which are parasitic on animals.

Sub-order 4. PUPIPARA.

This includes many parasites as *Sheep ticks*, etc.

Sub-order 5. APHANIPTERA.

Wingless flies, degraded by parasitism, includes the fleas.

CHAPTER 17

Sawflies and Midges

APPLE SAWFLY

Name *Hoplocampa testudinea* Order *Hymenoptera* (*4-winged flies*)

1. General

Description

Larva (Maggot)

APPEARANCE.	With *six* middle pairs of sucker feet.
COLOUR.	Cream coloured with brown head and final segment.
LOCATION.	(1) Inside the young fruits. (2) In the ground in cocoons (throughout winter).
APPEARS IN	May onwards.
DURATION.	Throughout winter.
REMARKS.	Distinguished from the caterpillar of the *codling moth* by its two extra pairs of sucker feet, and its dull appearance.

Pupa (Chrysalis)

APPEARANCE.	In cocoon, coated with soil.
COLOUR.	Cocoon yellowish.
LOCATION.	In ground, a few inches deep.
APPEARS IN	March.
DURATION.	2 to 3 weeks.

Adult Insect (Sawfly)

SIZE.	$\frac{1}{4}$ to $\frac{1}{3}$ inch.
COLOUR (WINGS).	Transparent, with brownish rims.
„ (BODY).	Reddish yellow: head black.
APPEARS IN	End of April to middle of May.
REMARKS.	Female lays eggs in the flowers on sunny days. Two broods may occur in the year.

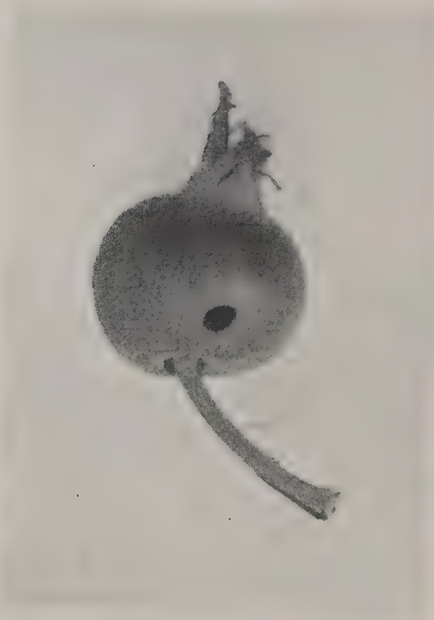


Fig. 142. Fruitlet infested by Apple Sawfly Maggot. Natural size.

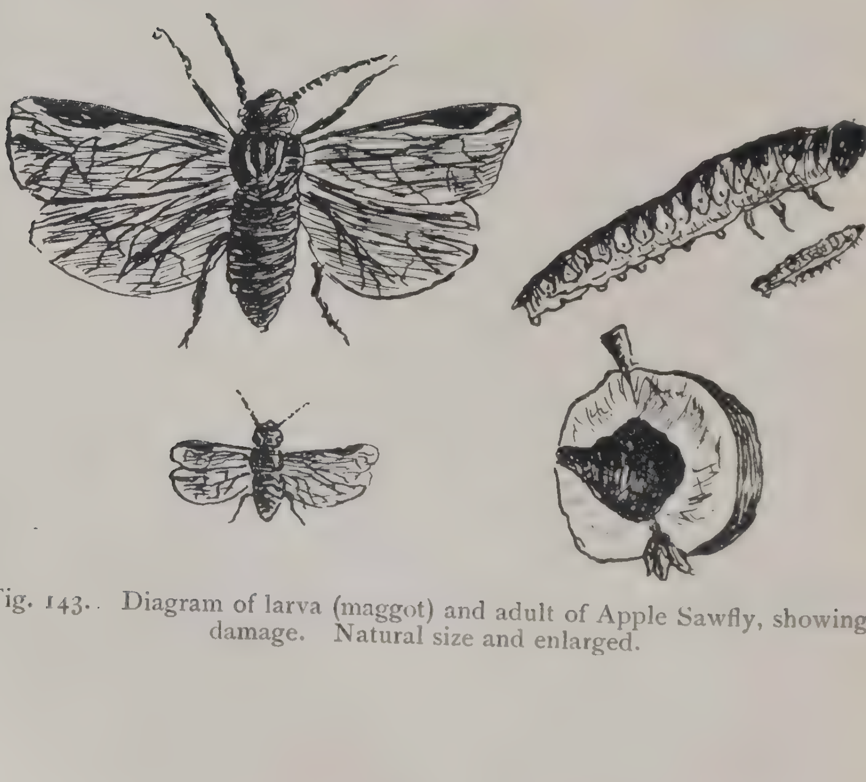


Fig. 143. Diagram of larva (maggot) and adult of Apple Sawfly, showing damage. Natural size and enlarged.

Ova (Eggs)

ARRANGEMENT.	Singly (as a rule).
LOCATION.	At base of flower.
APPEAR IN	May.
HATCHING PERIOD.	1 to 2 weeks.

Distribution

Widespread.

Life-history

The flies appear from the ground in late April or May, and lay their eggs, generally in the forenoon of sunny days, on the flowers. The young maggots enter the fruitlets and eat out large holes, causing "frass" to exude from the hole on the side of the apple.

Fig. 144. Maggot of Apple Sawfly entering young apple. Natural size.

Maggots often leave one fruit and enter another, and thus one grub may be responsible for damage to several apples.

The maggots are mature in 4 to 5 weeks, and then fall to the ground (if the fruit has not already fallen) and penetrate a few inches into the soil where the winter is passed, pupation taking place in the spring.

2. Economic

Trees Attacked

Apples.

Frequency of Pest

Common in certain localities.

Nature of Attack

The maggots eat out large holes in the fruit, and there is always a hole on the side of the apple, out of which much "frass" appears. A black cavity is formed, in the interior. Apples are occasionally scarred on the surface, when the maggot has failed to enter the apple.

Fig. 145. Fruitlet cut open to show damage caused by maggot of Apple Sawfly. Natural size.

Degree of Damage

Often serious.

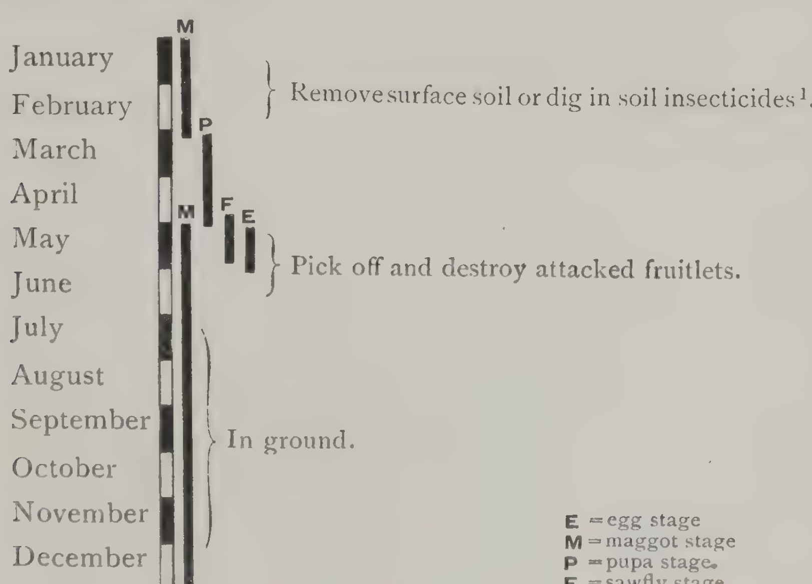
Preventive Measures

1. The use of SOIL INSECTICIDES[1] in winter, under the trees.
2. Removal of the surface soil for a few inches deep. This is only possible in small plantations and gardens. The soil should be buried deep or baked.

Remedies

Hand pick the infested fruits as soon as these are seen (they can readily be recognised by the holes on the side of the fruit exuding moisture and "frass") is the only remedy that can be used. This will prevent other fruits being attacked. Spraying with arsenate of lead has not proved successful.

Calendar of Treatment



[1] See page 433.

GOOSEBERRY AND CURRANT SAWFLY

Name *Nematus ribesii* Order *Hymenoptera* (*4-winged flies*)

1. General

Description

Larva (Maggot)

SIZE AND APPEARANCE.	Naked, with numerous black pimples.
COLOUR.	Green to bluish-green—growing darker with age.
LOCATION.	On leaves.
APPEARS IN	(First brood) May or earlier: other broods throughout summer.
DURATION.	5 to 6 weeks.
REMARKS.	The last brood winters in the soil and pupates in the following spring.

Fig. 146. Maggot (larva) of Gooseberry and Currant Sawfly. See also fig. 141, page 235.

Pupa (Chrysalis)

APPEARANCE.	In cocoons covered with particles of earth.
COLOUR.	Cocoons: yellow to brown.
LOCATION.	In the ground (except some of the summer broods).
DURATION.	Few weeks in early spring.

Fig. 147. Gooseberry and Currant Sawfly, showing various parts. Magnified.

Adult Insect (Sawfly)

SIZE.	About $\frac{1}{3}$ inch long.
COLOUR (WINGS).	Two pairs, transparent.
,, (BODY).	Variable { Female—yellowish. Male—black, with yellow band on thorax, and sides yellow.
TIME OF APPEARANCE.	April or May, and later (three broods during the summer).

Ova (Eggs)

APPEARANCE.	Oval.
COLOUR.	Pale greenish-white.
ARRANGEMENT.	In rows along ribs of leaf.
LOCATION.	Under surface of leaves.
HATCHING PERIOD.	5 to 12 days.
REMARKS.	Each egg is placed in a slit made by the "saw" of the fly.

Fig. 148. Diagram of various stages of Gooseberry and Currant Sawfly. Natural size and enlarged.

Distribution

Occurs all over Britain.

Life-history

The sawflies appear in April or May and lay their eggs on the under surface of the leaves, in rows on the ribs, each egg being placed in a slit made by the "saw" of the insect for this purpose. The maggots feed on the outer skin of the leaf first, then make holes through and finally spread over the plant, and voraciously devour the entire leaves. When mature, the maggots fall to the ground, form a cocoon just under the earth, pupate, and produce the next

brood. This occurs all through the summer, and as many as four broods may be produced. The mature maggots from the last brood winter in their cocoons in the ground and pupate in the following spring.

2. Economic

Trees Attacked

Gooseberry and red currant, occasionally black currants.

Frequency of Pest

Common.

Symptoms of Attack

Holes appear in the leaves of the plant, due to small, very active, caterpillar-like maggots, distinguished from caterpillars by their smaller size, pimply naked bodies and by having more "sucker legs" (14 in all).

Nature of Attack

The leaves are eaten and usually stripped by the maggots, and the gooseberries are also devoured.

Degree of Damage

Serious.

Preventive Measures

1. Where it is possible or practicable, e.g. in small gardens, the surface soil may be removed to a depth of 5 to 6 inches, and either baked and replaced or buried deeply and replaced by fresh soil from some other part. The hibernating maggot is thus destroyed, or prevented from reaching the surface.
2. The use of SOIL INSECTICIDES[1] is of benefit, if these are carefully applied, but is not so effective as the above treatment.

Natural Enemies

Many have been recorded, but few appear to be of much service in coping with attacks.

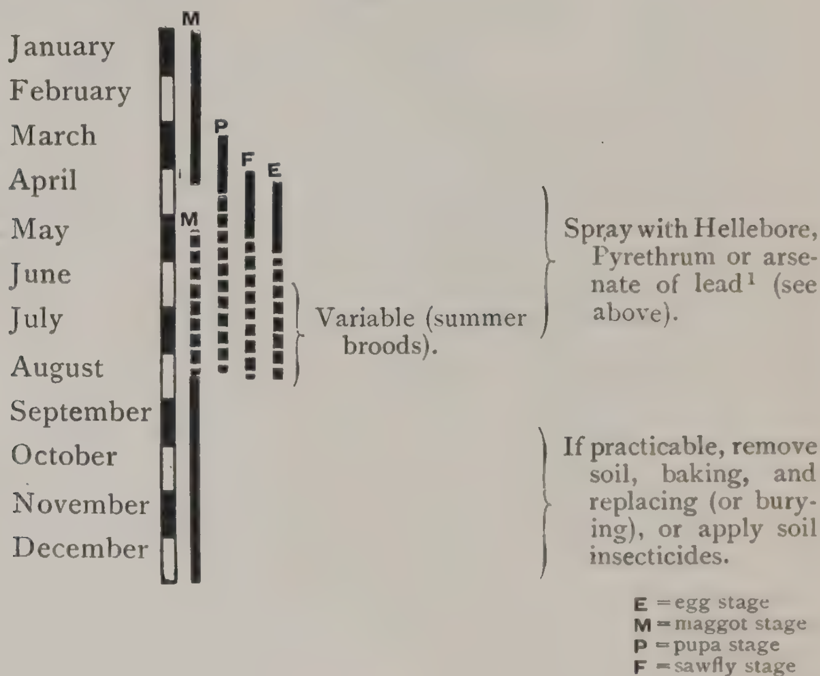
Remedies

1. HELLEBORE[2] powder either dusted on dry or applied as described on page 422 is most suitable and may be used within a few days of gathering the fruit. PYRETHRUM[3] is also suitable.

[1] See page 433. [2] See page 421. [3] See page 444.

2. Spraying with ARSENATE OF LEAD[1] as soon as the sawfly grubs appear is a remedy. Owing however to its poisonous nature, it must not be used within *a full month* of the time when the fruit is picked.
3. In small plantations, hand picking of the young maggots (or destroying by crushing on the leaves) is very serviceable if these are taken sufficiently early, i.e. before they spread over the plant. At this stage they make small shot holes in the leaves, and these should be carefully watched for the first signs of trouble.

Calendar of Treatment



[1] See page 397.

SLUG WORM ("Snag")

Name *Eriocampa limacina* Order *Hymenoptera* (*4-winged flies*)

1. General

Description

Larva (Maggot)

APPEARANCE.	Slimy and shiny (repulsive), later dull and wrinkled. Wide in front, tapering towards tail end.
COLOUR.	Green-yellow below.
LOCATION.	On upper surface of leaves.
APPEARS IN	June.
DURATION.	Throughout the winter in cocoons in soil.

Pupa (Chrysalis)

APPEARANCE.	In cocoons formed by grubs.
LOCATION.	In soil.
APPEARS IN	April—May.

Adult Insect (Sawfly)

SIZE.	$\frac{1}{4}$ to $\frac{1}{3}$ inch.
COLOUR (WINGS).	Transparent.
„ (BODY).	Shiny black.
APPEARS IN	Early June.

Ova (Eggs)

APPEARANCE.	Oval.
COLOUR.	White.
ARRANGEMENT.	In slits cut by the "saws."
LOCATION.	Under surface of leaves.
APPEAR IN	June.
HATCH IN	About a week.

Distribution

Widespread.

Life-history

The sawfly appears in small numbers in early summer. The eggs produce very repulsive-looking maggots, slimy and shiny in appearance. These produce blotchy spots on the leaves, feeding on the upper surface. In the final stage the grub becomes wrinkled and loses its slimy appearance. Winter is passed in the soil in cocoons and pupation takes place in spring.

Fig. 149. Maggot of Slug Worm and cast skin. Natural size.

2. Economic

Trees Attacked

Cherry, pear, plum.

Susceptible Varieties

Morello, frequent among cherries.

Frequency of Pest

Common.

Nature of Attack

The leaves are attacked: these are eaten from the *upper* surface and the *under skin* is left intact, producing blotchy spots on the leaves.

Fig. 150. Diagram of adult Sawfly of Slug Worm. Natural size and enlarged.

Degree of Damage

Often serious, since the tree is often induced to produce late leaf-buds and so is greatly weakened.

Preventive Measures

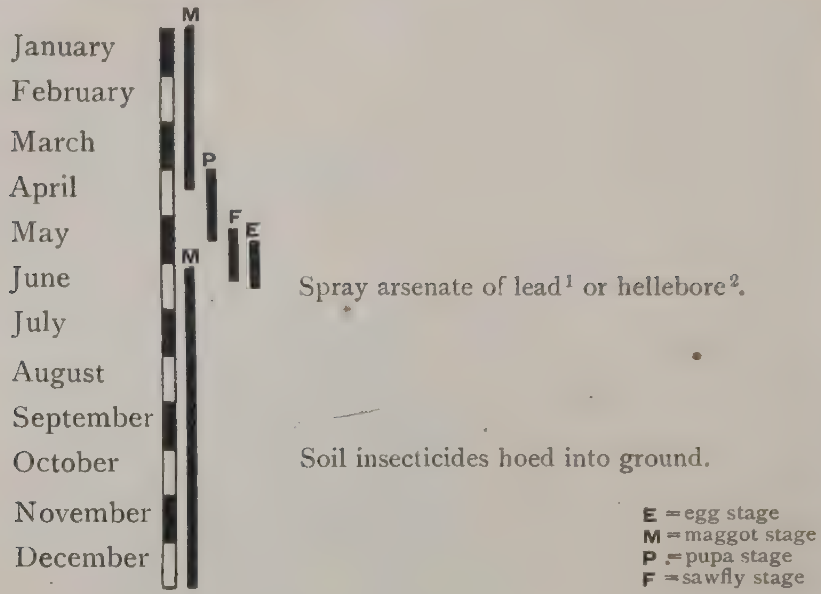
SOIL INSECTICIDES hoed into the soil during winter will destroy the hibernating maggots.

Remedies

The best remedy is spraying the attacked trees with ARSENATE OF LEAD[1]. (Care should be taken to avoid spraying fruit within one month of picking.) HELLEBORE[2] or PYRETHRUM[3] may also be used and will not poison the fruit.

[1] See page 397. [2] See page 421. [3] See page 444.

Calendar of Treatment



NUT SAWFLY

Name *Crœsus septentrionalis* Order *Hymenoptera* (*4-winged flies*)

1. General

Description

Larva (Maggot)

COLOUR.	Young—very pale: later greenish-blue: second and last segment, yellow, with black spots along sides.
LOCATION.	Near edges of leaf in rows.
APPEARS IN	July and August (second brood in September).
DURATION.	The last brood pass the winter in the ground and pupate in the following spring.
REMARKS.	The grubs maintain their hold on the leaf by their true legs (on first three segments of the body) and twist the rest of the body in all positions.

[1] See page 397. [2] See page 421.

Pupa (Chrysalis)

APPEARANCE.	In spindly cocoon.
COLOUR.	Brown.
LOCATION.	In the ground.
APPEARS IN	April and May (later brood July).

Fig. 156. Maggots (larvæ) of Nut Sawfly at work. $\frac{2}{3}$ natural size.

Adult Insect (Sawfly)

SIZE.	About $\frac{1}{2}$ inch long.
COLOUR (WINGS).	Transparent.
" (BODY).	Glossy black.
APPEARS IN	End of May—June.
REMARKS.	The hind pair of legs, unusually long, and the segments flattened.

Ova (Eggs)

LOCATION.	Placed in slits on the leaves made by the "saws."
APPEAR IN	June.

Distribution

Chiefly in South and West of England and widespread in Europe.

2. Economic

Trees Attacked

Nuts (cob, filbert, hazel), occasionally gooseberry.

Frequency of Pest

Fairly common.

Nature of Attack

The leaves are ravenously devoured.

Degree of Damage

Variable: occasionally serious.

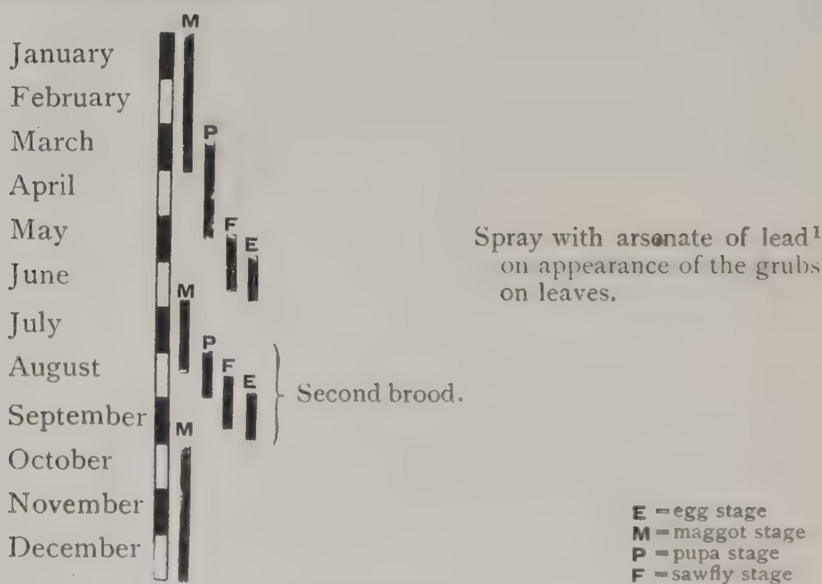
Natural Enemies

Many parasites attack this sawfly and consequently it does not usually appear in large numbers in two successive years.

Remedy

Spraying with ARSENATE OF LEAD[1].

Calendar of Treatment



[1] See page 397.

PLUM FRUIT SAWFLY

Name *Hoplocampa fulvicornis* Order *Hymenoptera* (*4-winged flies*)

1. General

Description

Larva (Maggot)

APPEARANCE.	Curved: about $\frac{1}{3}$ inch long.
COLOUR.	Cream, with pink tinge, with brown head.
LOCATION.	Inside fruitlet.
APPEARS IN	May and June.
DURATION OF STATE.	Throughout winter, in cocoons, in soil.
REMARKS.	A single grub may attack several fruits. The grub has six pairs of "sucker" legs and a tail pair and is thus distinguished from a true caterpillar.

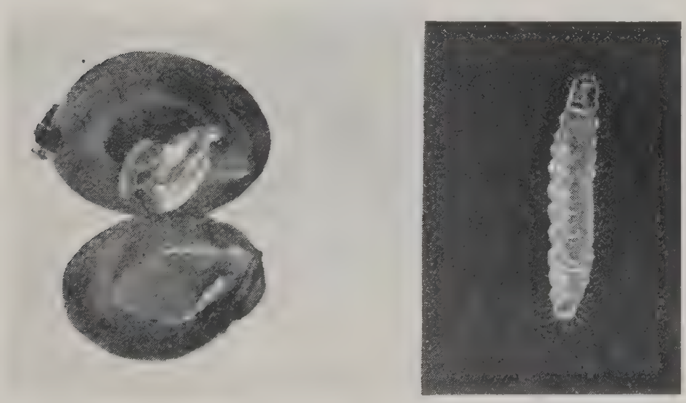


Fig. 152. Plum cut open to show larva of Plum Fruit Sawfly: also the maggot enlarged (× 3).

Pupa (Chrysalis)

APPEARANCE.	In the cocoons spun by the grubs.
LOCATION.	In soil.
APPEARS IN	February.

Adult Insect (Sawfly)

SIZE ACROSS WINGS.	About $\frac{1}{3}$ inch.
COLOUR (WINGS).	Transparent.
„ (BODY).	Black with yellow to brown legs.
APPEARS IN	April and May.
REMARKS.	Only one brood has been noticed in the year.

Ova (Eggs)

APPEARANCE.	Small and transparent.
COLOUR.	Greenish.
ARRANGEMENT.	Singly.
LOCATION.	In the blossom buds.
APPEAR IN	April and May.
HATCH IN	7 to 14 days.

Fig. 153. Diagram of various stages of Plum Fruit Sawfly. Natural size and enlarged.

Life-history

The egg is laid in the fruit bud, inside a deep saw-cut. The maggot hatches out and feeds in the developing fruitlet. It is paler than the *plum fruit moth caterpillar* (see page 155), and has two pairs more of sucker feet. Plums are often quite hollowed out by the maggot, which may attack several fruits in turn.

When mature, the maggot enters the ground, spins a brown cocoon and winters in this, pupating in the following February.

Only one brood apparently occurs.

2. Economic

Trees Attacked

Plums, chiefly greengages, but others are attacked.

Frequency of Pest

Not uncommon.

Symptoms of Attack

Fruitlets remaining undeveloped, falling, or (later) appearing with small holes made by the grub on leaving the fruit.

Nature of Attack

The fruit is injured and often almost destroyed by the maggot. Attacked plums will not keep.

Degree of Damage

Serious.

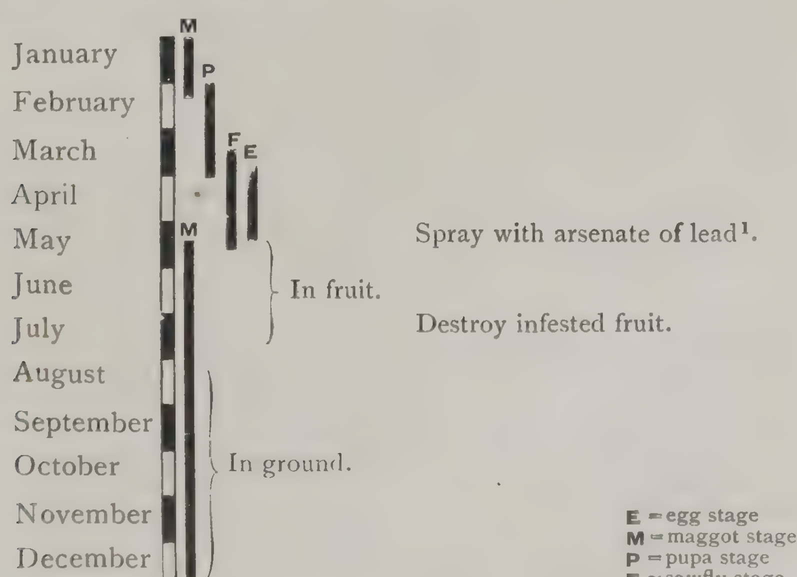
Preventive Measures

Destroy all fallen fruit and gather all attacked plums and burn them where possible.

Remedy

Early spraying of the blossoms with ARSENATE OF LEAD[1] should poison the young maggots.

Calendar of Treatment



[1] See page 397.

PLUM LEAF SAWFLY

Name *Cladius padi* Order *Hymenoptera* (4-*winged flies*)

1. General

Description

Larva (Maggot)

COLOUR.	Greenish with white sides: head dark brown.
LOCATION.	On leaves.
APPEARS IN	May, July (sometimes also September).
DURATION.	About three weeks (except last brood which winter in the ground in silken cocoons).

Pupa (Chrysalis)

APPEARANCE.	In the cocoons of the grubs.
COLOUR.	Pale grey.
LOCATION.	In soil.
DURATION.	9 to 12 days.
APPEARS IN	April, June (August).

Adult Insect (Sawfly)

COLOUR (WINGS).	Transparent.
,, (BODY).	Black, with two grey spots: legs white.
APPEARS IN	May to June and later (2 to 3 broods).
REMARKS.	In the female, the feelers (antennæ) are specially long.

Ova (Eggs)

ARRANGEMENT.	Irregular.
LOCATION.	Under surface of leaves.
APPEAR IN	May and June.
HATCH IN	7 to 8 days.

Distribution

Widely distributed.

2. Economic

Trees Attacked

Plums, also roses, sloes, etc.

Frequency of Pest

Common, but not often in dangerous numbers.

Fig. 154. Diagram of various stages of Plum Leaf Sawfly. Natural size and enlarged.

Nature of Attack

The leaves are holed, and often shrivel up.

Remedies

1. Spray with arsenate of lead[1].
2. Shake off the maggots (which readily fall) and prevent re-ascent by banding the trees (or collect and destroy).

[1] See page 397.

SOCIAL PEAR SAWFLY

Name *Pamphilus flaviventris* Order *Hymenoptera* (*4-winged flies*)

1. General

Description

Larva (Maggot)

APPEARANCE.	Without sucker feet, about 1 inch (mature).
COLOUR.	Yellowish: orange-yellow later with two brown stripes.
LOCATION.	Amongst leaves in *tents* of silk.
APPEARS IN	May and June.
DURATION.	Throughout winter in cocoons in soil.
REMARKS.	Distinguished from the *Lackey tents* (page 124) by greater width and dirty appearance, also the grub is very different from Lackey caterpillar.

Pupa (Chrysalis)

APPEARANCE.	In grub cocoons.
LOCATION.	In soil.
APPEARS IN	April.
REMARKS.	Are said to occasionally remain in the ground throughout summer till next season.

Adult Insect (Sawfly)

SIZE ACROSS WINGS	$\frac{1}{3}$ to $\frac{1}{2}$ inch.
COLOUR (WINGS).	Transparent.
„ (BODY).	Black: legs yellow.
APPEARS IN	May and June.

Ova (Eggs)

APPEARANCE.	Oval and sticky.
COLOUR.	Yellowish.
ARRANGEMENT.	In rows: about 50 in all.
LOCATION.	On under surface of leaves.
APPEAR IN	May and June.
HATCH IN	About a week.

Fig. 155. Social Pear Sawfly larvæ, showing also damage. Natural size.

Distribution

Widespread.

Life-history

The sawflies appear in May and June, and lay eggs under leaves on sunny days. The maggots spin webs and gradually increase the size of these until they may reach considerable proportions. They resemble the *Lackey* tents, but appear darker, and the maggots are easily distinguished from the striking Lackey caterpillars (see page 124). When frightened they expel a clear, brown fluid.

Fig. 156. Diagram of adult of Social Pear-Sawfly. Natural size and enlarged.

They move with difficulty on a smooth surface, having no sucker feet. When mature, they fall to the ground and spin cocoons in which the winter is passed in the soil, pupating the following spring.

2. Economic

Trees Attacked

Pears.

Frequency of Pest

Fairly common.

Nature of Attack

The maggots devour the leaves inside the "webs" or "tents."

Fig. 157. Eggs of Social Pear Sawfly hatching out on leaf. Enlarged (× 3). Inset natural size.

Degree of Damage

Serious: trees may be totally stripped of leaves.

Preventive Measures

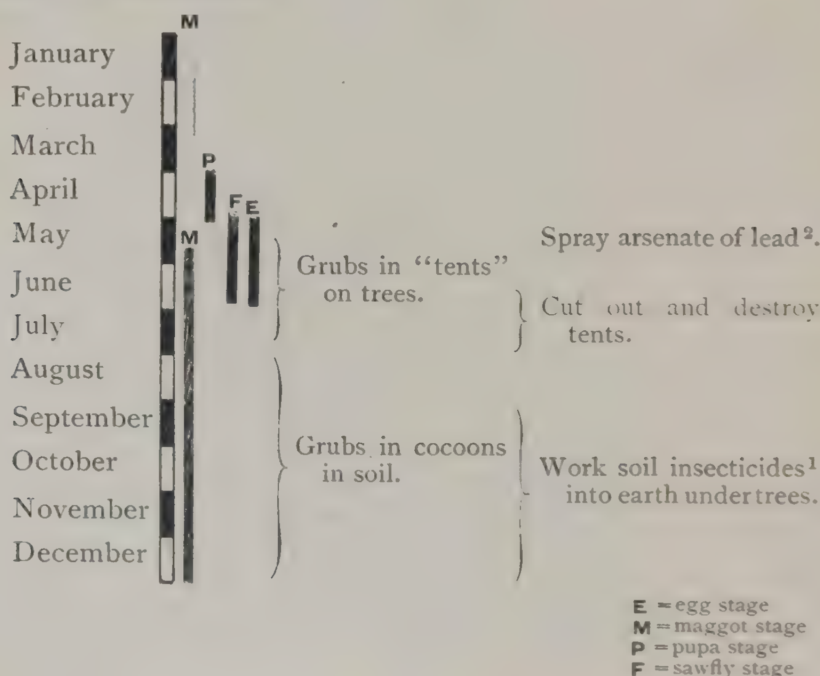
SOIL INSECTICIDES[1] hoed into the ground around trees will destroy the hibernating caterpillars and prevent attack the following year.

Remedies

As for the *Lackey caterpillar* (page 126).

1. The destruction of the tents is by far the best means of dealing with the pest.
   Since the maggots readily fall to the ground when disturbed, care must be taken that none escape in this way.
   Pails of hot lime are recommended for placing the tents in after cutting out from the trees.
2. If ARSENATE OF LEAD[2] is used, it must be sprayed on the trees before the larvæ have had time to construct tents.

Calendar of Treatment



[1] See page 433. [2] See page 397.

PEAR MIDGE

Name *Diplosis pyrivora* Class *Cecidomyrdæ* (*Gall flies*)
Order *Diptera* (*2-winged flies*)

1. General

Description

Larva (Maggot)

APPEARANCE.	Small (not over $\frac{1}{7}$ inch), legless.
COLOUR.	Yellowish white: brown head.
LOCATION.	In young fruits.
PROGRESSION.	By "jumping."
APPEARS IN	April and May.
DURATION.	Usually till late autumn.
REMARKS.	The maggots leave the pears when mature in June and enter the ground, forming small cocoons.

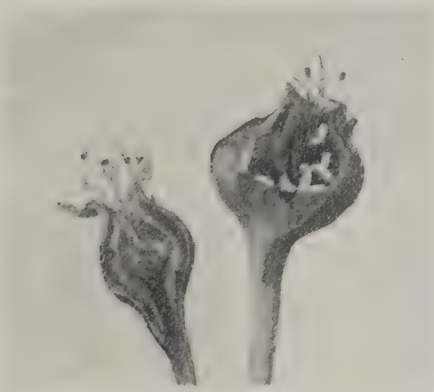


Fig. 158. Healthy and infested fruitlets cut open to show maggots and damage. Natural size.

Pupa (Chrysalis)

APPEARANCE.	Inside the grub-cocoons.
LOCATION.	In the ground.
APPEARS IN	Late autumn or winter.
DURATION.	Till following spring.

Adult Insect (Fly)

SIZE.	$\frac{1}{10}$ to $\frac{1}{8}$ inch.
COLOUR (WINGS).	Two: transparent.
" (BODY).	Dark grey to black: legs and feelers long and brownish.
APPEARS IN	Middle April to middle May.
REMARKS.	The female has very long egg-depositor.

Fig. 159. Diagram of various stages of Pear Midge, showing also injury to fruitlet. Natural size and enlarged.

Ova (Eggs)

APPEARANCE.	Long and pointed.
COLOUR.	White.
ARRANGEMENT.	10 to 30 in a group.
LOCATION.	In blossoms (usually on the *anthers*)
APPEAR IN	April and May.
HATCHING PERIOD.	4 to 6 days.

Distribution

Widespread in Britain, Europe and the States.

Life-history

The flies appear in spring, and after fertilisation the female lays her eggs with her long egg-depositor in the flowers. These hatch into minute maggots which infest the young fruitlets, eating out the interior. By June they are mature and leave the decayed fruit, exhibiting the curious jumping movements characteristic of the midges. They penetrate the soil to a depth of 1 to 2 inches and, spinning a slender white cocoon, remain till autumn or winter when pupation takes place.

2. Economic

Trees Attacked

Pears.

Susceptible Varieties

Comice not often attacked.

Frequency of Pest

Common.

Symptoms of Attack

The attacked fruitlets swell rapidly and appear to be growing at a faster rate than normal: later they become mis-shapen and assume many curious forms.

Nature of Attack

The fruitlets are eaten out in the interior by the grubs, and much black "frass" is produced. The pears often fall to the ground, but occasionally remain on the trees. They crack and rapidly become rotten.

Degree of Damage

Very serious. In many places the cultivation of pears has been abandoned from this cause.

Preventive Measures

1. In gardens, and where the facilities are forthcoming, removal of the soil to a depth of 3 to 4 inches, and burying this or baking it in the autumn or winter kills the maggots and pupæ, and prevents attack.
2. KAINIT[1] laid upon the soil at the rate of about 5 cwt. per acre,

[1] See page 426.

when the maggots were entering, has been found very beneficial. This should be applied by the first week in June to be effectual.

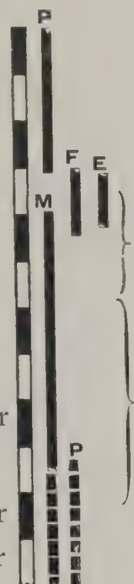
3. Run poultry in the orchards from June till August and again in spring.
4. Spraying the unopened blossom with SOFT SOAP[1] and NICOTINE[2] wash has been found to prevent egg-laying.
5. Wherever possible, all infested fruitlets should be picked and burnt as soon as they are detected. The maggots are thus destroyed.

Fig. 160. One infested and several healthy pear fruitlets. Natural size.

Where the midge has established a hold, it is a wise, if somewhat drastic, plan to kill the blossoms and so lose the fruit for a season. By this means the midge is starved out. This is best done by spraying heavily with PARIS GREEN[3] just as the blossoms burst. This plan is however of little avail if growers in surrounding plots do not take the same measures, and is an instance of the necessity for combined action, or for compulsory spraying, discussed in a previous chapter[4].

[1] See page 452. [2] See page 436. [3] See page 442. [4] See page 7.

Calendar of Treatment



January		
February		Run fowls over ground.
March		Spray heavily with soft soap[1] and nicotine[2], in bad cases destroy blossoms with Paris green[3].
April		
May	Maggots in fruitlets.	Pick off infested fruit.
June	Maggots going to earth.	Dress ground with kainit[4] or run fowls over ground.
July		
August	Maggots in ground.	
September		
October		
November		Remove surface soil and bake or bury it.
December		

E = egg stage
M = maggot stage
P = pupa stage
F = fly stage

[1] See page 452. [2] See page 436.
[3] See page 442. [4] See page 426.

APHIDES

AND

PLANT BUGS

(*HEMIPTERA*)

CHAPTER 18

Aphides and Plant Bugs

(HEMIPTERA)

1. General

All fruit trees and plants have one or more species of these small, but very injurious, pests. They all agree in living upon the sap of the trees which is obtained by means of a jointed beak. This is inserted into the tissues of the leaf, etc.

The aphides ("green flies") vary a good deal in colour but are otherwise, in many cases, very similar.

They practically all secrete a sticky fluid, termed *Honey-dew*, on which often grows a black fungus which greatly disfigures the leaves. They often cluster on the leaves and stems so closely as to form a continuous covering.

Five forms occur throughout though not always on the same host plant, thus:

(*a*) STEM-MOTHER: large wingless aphis, produced from the egg, or wintering in sheltered spots.

(*b*) WINGLESS FEMALE (unsexed[1]) or *louse*, the progeny of (*a*).

(*c*) WINGED FEMALE (unsexed) often migratory to other plants.

(*d*) WINGLESS EGG-LAYING FEMALE (sexual) laying the eggs after fertilisation by the

(*e*) MALE (either with or without wings).

In addition to these, so-called pupæ (more correctly *nymphs*) are produced with wing-buds, before the flies appear.

The unsexed winged forms of the insect are produced in the summer, begetting living young, and these continuously produce living broods of "lice" all the summer. These, in the autumn, give rise to a second

[1] The word **unsexed** is used to denote the form which, although capable of bearing young, has no sexual organs for reception of the male. (The scientific term is *viviparous* and for the sexual egg-laying female the word *ovigerous* is employed.)

brood of unsexed winged females. Males and females are now produced and eggs laid which remain over the winter and hatch in the spring, giving rise to the *stem mothers* or *mother queens*.

In some cases, only the winged forms and the "lice" occur on fruit: in others all forms occur, while quite frequently, the winged females fly away to some other host plant in the summer and similar winged females return in the autumn. These give rise to sexual forms and eggs are laid upon the fruit plants.

Aphides are capable, under suitable conditions, of extremely rapid increase. Conversely, in unsuitable conditions, they may all rapidly disappear.

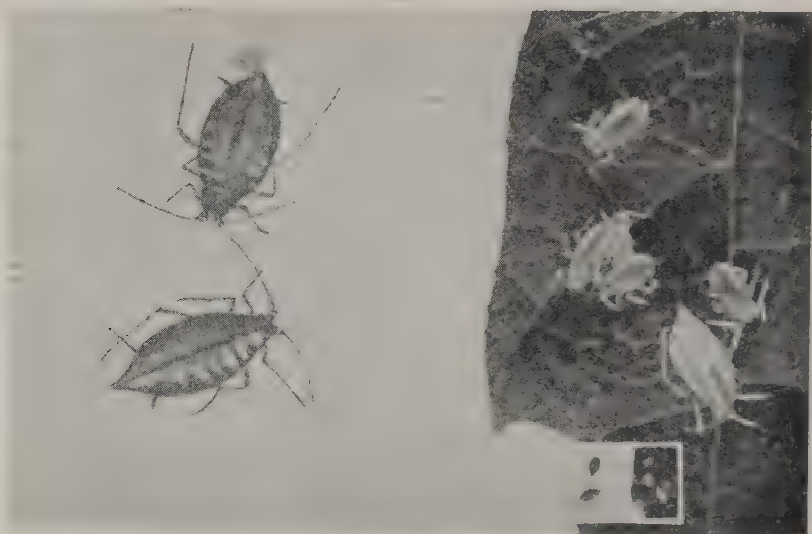


Fig. 161. Hop aphides. Enlarged and natural size (inset).

Aphides usually attack the leaves mainly. A few also infest the flower buds, and one species, the *Woolly Aphis*, attacks the trunk, branches and roots.

Many aphides are covered with a fine "meal" or so-called *wax*. This resists sprays of all kinds, and is difficult to penetrate. In order to kill aphides it is necessary to employ a *contact poison* such as NICOTINE[1], combined with a wetting substance, of which SOFT SOAP[2]

[1] See page 436. 5 ozs. per 100 gallons is a suitable quantity to use.
[2] See page 452.

Fig. 162. Two varieties of aphis on an apple tree. Woolly Aphis (below), Blue Apple Aphis (above) in curled leaves.

is the most successful (see chapter 25) and to use a high pressure spray. rather coarse—see fig. 250, page 634.

Many claims have been made for various proprietary sprays to destroy the eggs of the aphis and the apple sucker during the winter. Careful investigation has shown however that this is not feasible, the limit of resistance being practically equal to that of the tree itself.

The APPLE SUCKER (Psylla) infests the flower buds and is a very troublesome pest. Blooms attacked invariably die. The treatment is as for aphis attacks.

In addition to a *nicotine and soap* spray, benefit has been found from spraying in the spring with LIME[1] which hinders the hatching of the eggs. This treatment may be given RIGHT UP TO THE APPEARANCE OF THE BLOSSOM TRUSSES without injury (see figs. 244, 245, pages 617, 618).

The CAPSID BUG is an extremely destructive pest on apples in the Cambridge district and in the western counties. It is a curious instance of change of food plants by an insect. Until recent years, the apples were not attacked, the bug feeding upon willows.

Soft soap and nicotine wash (the latter in higher strength than for aphis) is the best remedy.

The Scale Insect belongs to this order of insects, but as it offers an entirely different problem from the grower's point of view, it is separately dealt with (chapter 21, page 355).

None of these insects have a definite *pupa* stage. After a certain number of moults, wing-buds appear, but the insect in this stage is quite active. It is termed a *nymph*. After a few more moults, the winged fly appears.

2. Scientific

Aphides are all of a similar form. They possess a sucking jointed beak, prominent eyes and antennæ (feelers), three pairs of jointed legs, and curious "horns" termed *cornicles*, one on each side of the body at the hinder end.

They may be light to dark green, brown, purple or black in colour, naked and transparent or opaque and "mealy." The Woolly Aphis secretes a tangled mass of white threads which cover its body and hang down in masses on the branches.

[1] See page 428.

Classification

Order **Hemiptera**

Sub-order HETEROPTERA (with dissimilar wings).

The fore-wings are tough and usually opaque and fold over the under membranous pair.

Capsid-bug, *Plesiocoris rugicollis.*

Sub-order HOMOPTERA (with similar wings).

Two pairs of membranous wings. Usually erected over the back when at rest.

Family *Aphidæ.*

This includes all the aphides attacking fruit as described in this chapter.

Family *Psyllidæ.*

The chief pest on fruit is the Apple Sucker, *Psylla mali.*

Family *Circidæ.*

Leaf-hoppers, species of *Typhocybidæ*, *Chlorita*, etc.

Family *Coccidæ.*

These are the "scale insects." The chief pests are:

Mussel Scale, *Lepidosaphes ulmi.*

Brown Scale, *Lecanium persicæ.*

CHAPTER 19

Aphides

BLUE APPLE APHIS

Name *Aphis malifoliæ*[1] Family *Aphidæ* Order *Hemiptera*

1. General

Description

Adult Insect

All five forms are known as follows:

(*a*) STEM-MOTHER (from the egg) produces living young.
Colour—usually blue, or grey-blue, but very variable, may be brownish, reddish, or almost black: mealy.

(*b*) WINGLESS FEMALE (unsexed), as for (*a*).

(*c*) WINGED FEMALE (unsexed) produced by (*b*) in summer (brood 1). These fly to some other host plant at present not located, and return (brood 2) in autumn to the apple.
Colour—thorax and head black, abdomen dull reddish, feelers and horns black.

(*d*) WINGLESS EGG-LAYING FEMALE (sexual), from (*c* 2), lays eggs on the apple after fertilisation by (*e*).
Appearance—small (½ size of (*a*)).
Colour—yellow to greenish-yellow.

(*e*) MALE (winged).
Appearance—½ size of (*c*). Thorax dark, abdomen dull red with dark patches.

Ova (Eggs)

APPEARANCE.	Oval.
COLOUR.	Shiny black.
ARRANGEMENT.	Singly or small groups.
LOCATION.	Shoots, angles of buds, or trunk.
APPEAR IN	Late autumn.

[1] Fitch.

Larva (Louse)

COLOUR.	Very variable: green, pink, reddish, becoming bluish later, and mealy.
LOCATION.	On or in buds or leaves. Leaves tightly curled.

Distribution

Widely distributed in Britain and abroad.

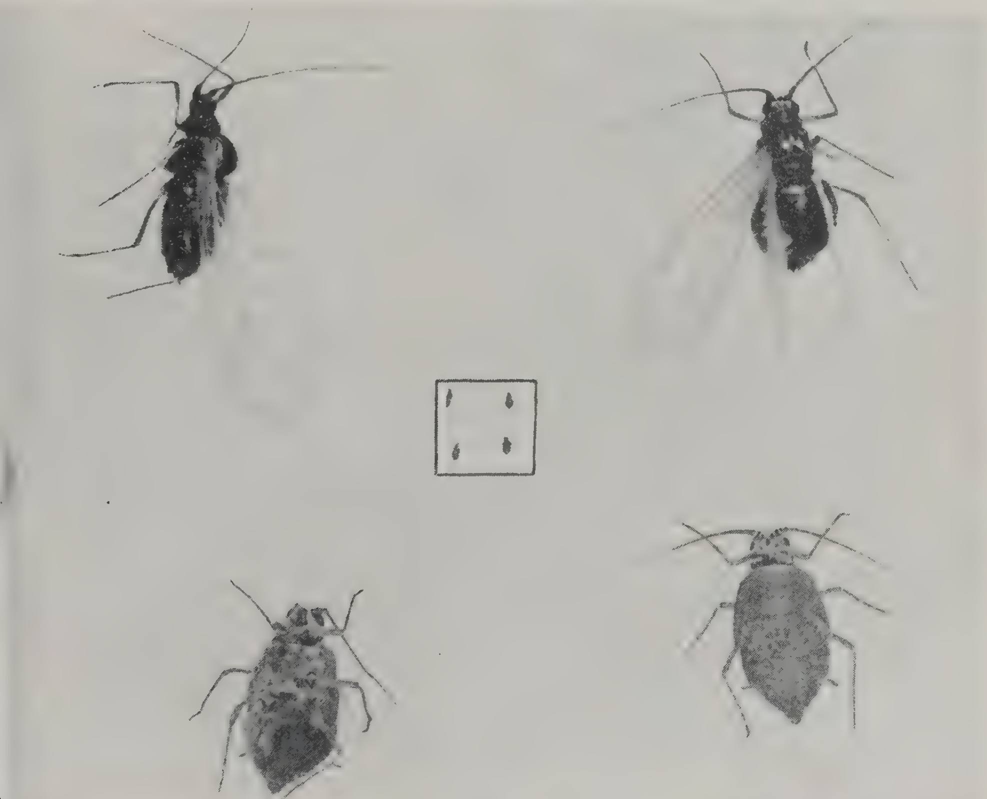


Fig. 163. Blue Apple Aphis. Magnified. Inset natural size.

Life-history

This "blue bug" breeds by means of eggs laid upon the trees by the sexual females in the autumn. These hatch out in April and the young lice gather upon the buds and enter them as they open. Later they feed upon the leaves, and cause these to curl very tightly. Flies are produced in the summer which leave for some

Fig. 164. Blue Apple Aphis, showing curled leaves and cast skins. ($\frac{3}{4}$ natural size.)

other plant (at present undetected) and similar flies return to the apples in autumn and produce sexual females and males when the eggs are laid.

2. Economic

Trees Attacked

Apples, and sometimes pears.

Frequency of Pest

Very common.

Nature of Attack

The leaves and shoots are attacked, and the former become tightly curled. Much honey-dew is produced and this appears to poison the leaves which often turn brown and fall off. The shoots and often the young fruit become distorted and stunted in growth.

Duration of Attack

Until mid-July when the aphides commence to disappear, being gone entirely usually by the end of the month.

Degree of Damage

Usually very serious.

Preventive Measures

1. Spraying in *autumn* with SOFT SOAP[1] and NICOTINE[2], or other efficient insecticide, kills the egg-laying females and prevents future attack. Carefully prepared PARAFFIN EMULSION may be used at this period.
2. LIME SPRAYING[3] in March has been found beneficial in preventing the successful hatching out of eggs. It has not been found injurious to spray, even as late as when the blossom trusses are appearing (see fig. 244, page 616).

Natural Enemies

Ladybirds and other beneficial insects appear in summer, but too late to prevent damage.

Remedies

Spray *early* in the spring[4] with SOFT SOAP[1] and NICOTINE[2] (no other insecticide is as efficient for this purpose) when as little

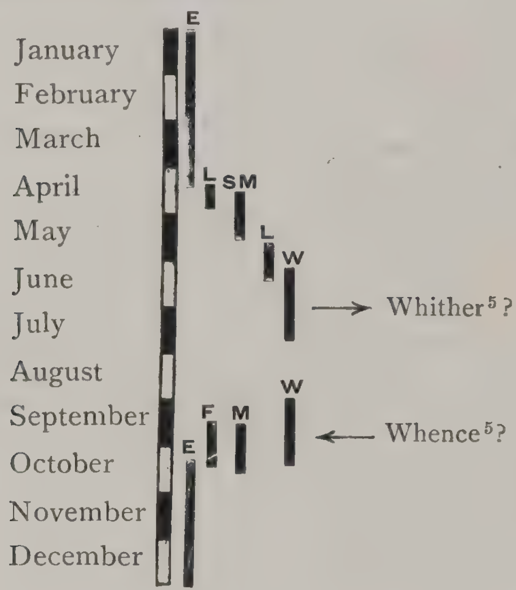
[1] See page 452. [2] See page 436. [3] See page 428.
[4] See fig. 193, page 341.

curling of the leaves has occurred as possible. 4 to 5 ozs. of nicotine per 100 gallons of soapy wash is required (see page 438).

Remarks

In spraying, a somewhat *coarse spray* with a *high pump-pressure* (over 100 lbs. per square inch) should be used. The adjustment of nozzle shown on fig. 250, page 634 is suitable.

Calendar of Treatment



Spray lime[1] on shoots.
Spray early with soft soap[2] and nicotine[3].

Spray with soft soap[2] and nicotine[3] or paraffin emulsion[4], etc.

E = egg stage
L = lice
SM = stem-mother
W = winged female (unsexed)
M = male
F = female (egg-laying

[1] See page 428. [2] See page 452. [3] See page 436. [4] See page 417.
[5] Professor Theobald has recently shown that one, at any rate, of the host plants to which the winged females fly is the *plantin* (rib-wort).

THE APPLE-OAT APHIS

Name *Siphocoryne avenæ*[1] Family *Aphidæ* Order *Hemiptera*

1. General

Description

The egg stage is passed on the apple and pear, and the flies migrate to various cereals, especially oats and barley, in the summer, returning in the autumn. The usual series of adult forms appear:

(*a*) STEM-MOTHER (from egg), produces living young on the apple and pear.
Appearance—green to yellowish-green. Feelers green with dark tips. Horns greenish-brown to brown.
Appears—about end of April.

(*b*) WINGLESS FEMALE (unsexed), the adult product of (*a*), produces living young: appearance as for (*a*).

(*c*) WINGED FEMALE (unsexed), occurs in May and June (1) and in autumn (2), flies to, and returns from, various cereals (see above).
Appearance—head and thorax black, abdomen green, with black spots on sides, feelers black, horns brown to greenish-brown, short.
(2) smaller than (1).

(*d*) WINGLESS EGG-LAYING FEMALE (sexual), produced from offspring of (*c* 1) late in autumn: lays its eggs after fertilisation by (*e*).
Appearance—small, yellowish-green.

(*e*) MALE (winged), appears at same time as (*d*): similar in appearance to (*c* 2) but smaller.

Ova (Eggs)

APPEARANCE.	Oval, shiny black.
LOCATION.	At junction of buds and on spurs.
APPEAR IN	Late autumn.
HATCH IN	Spring.
DURATION.	Throughout winter.

Distribution

General in Europe.

[1] *Aphis prunifoliæ* (Fitch).

Life-history

This aphis does not differ in its history from the green apple aphis (page 283) except that it leaves the apples and pears in summer and flies to various cereals, to return in autumn.

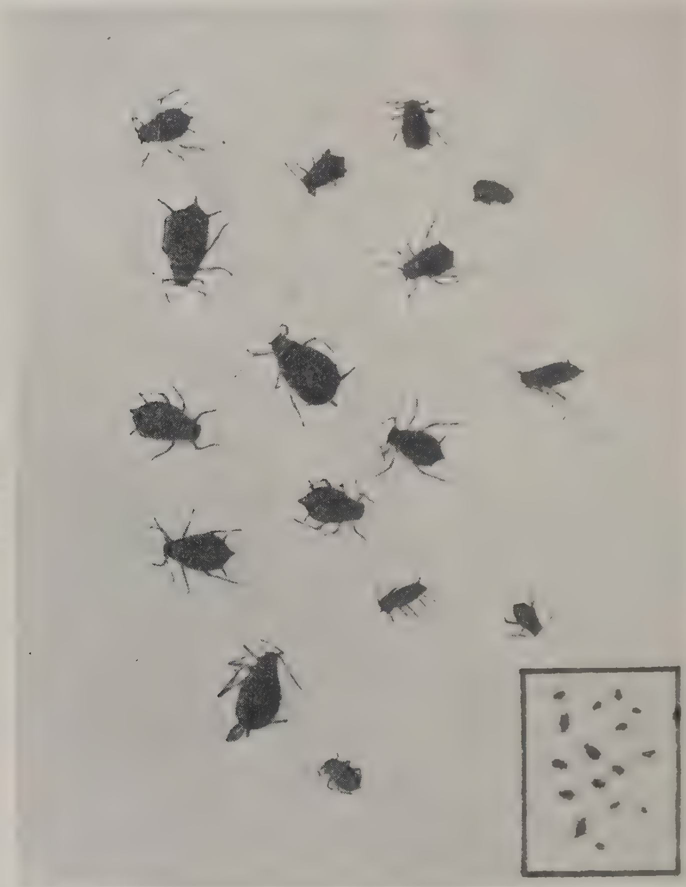


Fig. 165. Apple-oat Aphis (from the apple). Magnified and natural size (inset).

2. Economic

Trees Attacked

Apples, pears.

Frequency of Pest

Not so common as the other two species (Green and Blue).

Nature of Attack

The blossoms, as well as the leaves and shoots, are attacked and these, in bad cases, turn brown and die.

Remedies

As for green apple aphis.

Fig. 166. Aphis (from corn), probably same as fig. 165 (?). Magnified and natural size (inset).

GREEN APPLE APHIS

Name *Aphis pomi*[1] Family *Aphidæ* Order *Hemiptera*

1. General

Description

Adult Insect

Five forms occur as follows:

(*a*) Stem-mother. This is the mature form from the eggs after hatching in spring. She produces living young continuously during the spring and summer.

Colour—greenish or greyish, mottled yellow: black "horns," feelers black at tip.

Shape—round.

Appears in—spring.

[1] De Geer.

(*b*) Wingless female (unsexed), the adult product of (*a*). Produces living young continuously.
Colour—green with two dark spots on head: "horns" long and dark.
Shape—oval.
Appears—throughout spring and summer months.

Fig. 167. Green Apple Aphis magnified. Inset natural size.

(*c*) Winged female (unsexed), produced by (*b*) from pupæ (nymphs) in certain numbers in July and August. Produces living young.
Colour—brownish-black thorax, green abdomen, wings transparent.
Shape—slender.
Appears in—July and August.

(*d*) Wingless egg-laying female (sexual), produced by offspring of (*c*) late in autumn: lays its eggs after fertilisation by (*e*).
Colour—green-yellow.
Shape—smaller than foregoing.
Location—firmly attached to underside of leaves.

(*e*) WINGLESS MALE, appears at same time as (*d*).
Colour—yellow-brown.
Shape—extremely small.

Ova (Eggs)

APPEARANCE.	Oval, small.
COLOUR.	Shiny black.
ARRANGEMENT.	In large masses.
LOCATION.	On shoots, or base of buds.
APPEAR IN	Usually November.
HATCHING PERIOD.	Late April.
DURATION.	About 5 to 6 months.
REMARKS.	Eggs which are not fertile gradually shrivel up.

Larva or "Louse"

	(1) From eggs.	(2) From "stem-mothers."
COLOUR.	Bright yellowish-green.	Green with dark marks on head.
LOCATION.	On shoots or leaves.	On shoots or leaves.
APPEARS IN	Late April.	Throughout summer.
NUMBER OF MOULTS.	Three.	Three.
DURATION.	Varies according to weather.	Variable.
REMARKS.	Grows slowly in cold, rapidly in warm weather: in both cases the adult females are produced and some of (2) become winged females about July and August.	

Nymph (Pupa)

APPEARANCE.	Covered with mealy powder: with wing-buds.
COLOUR.	Greenish-yellow.
LOCATION.	On leaves.
APPEARS IN	July and August.
NUMBER OF MOULTS.	One.
DURATION.	Few days (variable).
REMARKS.	These produce the winged females.

Distribution

Widespread.

Life-history

The eggs hatch out in late April and produce the lice which grow into the *stem-mothers* (*a*). These produce living young producing adult *unsexed females* (*b*), some of the progeny of which turn to nymphs (pupæ) and produce the *winged unsexed females* (*c*). From these (which do not leave the trees) living young are produced, some of which give rise later to *wingless sexual females* (*d*) and *males* (*e*), both very small, especially the males. Eggs are laid in early winter which hatch out the following spring.

Fig. 168. Eggs of Green Apple Aphis on stem. Natural size.

2. Economic

Trees Attacked

Apples.

Frequency of Pest

Very common.

Nature of Attack

The young leaves, and later on the older leaves and shoots are attacked, but mostly the top parts of the branches. The leaves curl up very soon and enclose the aphis in a protected pocket. "Meal" and "honey-dew" is produced.

Duration of Attack

Throughout spring, summer, and autumn.

Degree of Damage

Sometimes serious, but much less so than the "blue aphis." The leaves are sometimes destroyed, and the shoots distorted and prevented from growing.

Fig. 169. Green Apple Aphis on apple shoots, slightly reduced. (Early summer.)

Fig. 169 *a*. Sexual females and males of Green Apple Aphis in autumn. Eggs are being deposited on the branch.

Preventive Measures

1. Destroy prunings, as these will probably have many eggs on them.
2. Spraying in early spring with thick LIME WASH[1], so as to cover the shoots and prevent the eggs from successfully hatching, has had a considerable measure of success (see also page 274).

Remarks

Many statements have appeared in the past as to the possibility of destroying aphis eggs by caustic and other winter washes. It has now been fairly definitely established that *no winter wash can be relied upon to kill the eggs*[2].

Remedies

Spray with a SOAP WASH[3] containing an efficient insecticide (chapter 26) (nicotine[4] is very suitable) *in the autumn.* Reliable compound washes may also be used.

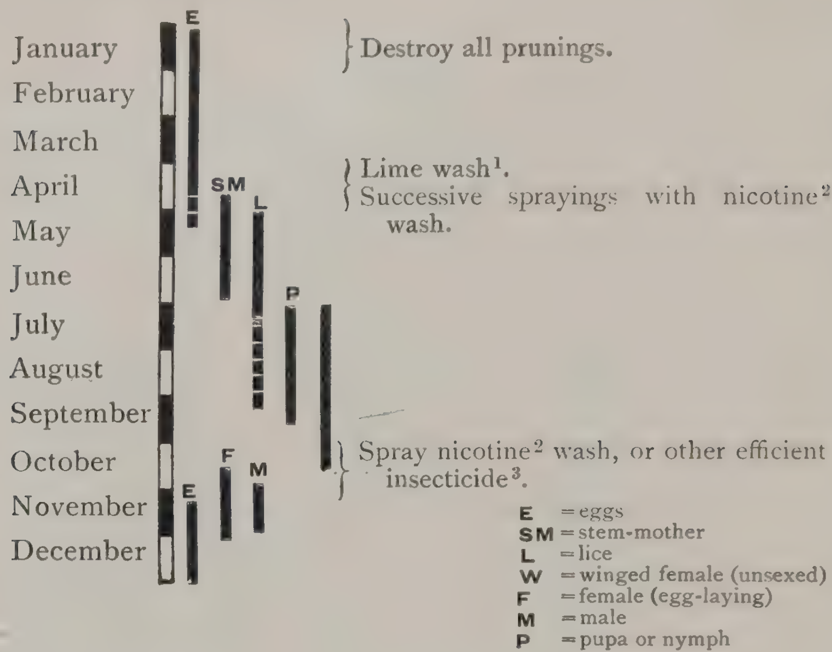
Spraying in spring is better than not spraying at all, but it is difficult to reach the aphides, on account of the tightly curled leaves. This would not matter if the trees were sprayed just as the eggs hatched, before the leaf curling started, but unfortunately, the hatching period is usually a long one, and many sprayings would have to be given to be sure of killing all the aphides. If spray washing is used, a nicotine[4] spray is most suitable.

Remarks on Remedies

A usual percentage of nicotine to employ for this aphis is 4 to 5 ozs. per 100 gallons of finished wash. Nozzle adjustment for spraying, as fig. 250, page 634. A high pump-pressure is necessary (100 lbs. per square inch upwards).

[1] See page 428.
[2] A proportion of eggs always shrivel up because they are unfertile, and this has mislead many observers.
[3] See page 452. [4] See page 436.

Calendar of Treatment



BLACK CHERRY APHIS

Name *Myzus cerasi*[4] Family *Aphidæ* Order *Hemiptera*

1. General

Description

Adult "Fly" (winged unsexed female)

SIZE.	About $\frac{1}{12}$ inch long.
COLOUR (WINGS).	Transparent.
,, (BODY).	Thorax black, abdomen green, horns black.
APPEARS IN	July and autumn.

[1] See page 428.
[2] See page 436.
[3] See page 390.
[4] Fabricius.

REMARKS.	All the usual forms of adult, (*a*) to (*e*), occur, the winged unsexed females disappearing in summer and returning in autumn like the plum leaf-curling aphis (see page 315). The flies leave the cherries for some other host-plant and return in the autumn, when the male and egg-laying females appear.

Ova (Eggs)

COLOUR.	Shiny black.
LOCATION.	On shoots (or suckers near the ground).
APPEAR IN	September to November.
HATCHING PERIOD.	Spring.
DURATION.	Throughout winter.

Larva or "Louse"

COLOUR.	Shiny black (pale when young).
LOCATION.	Leaves and shoots.
APPEARS IN	Spring.
DURATION.	Till late July.

Pupa or Nymph

COLOUR.	Olive green.
LOCATION.	Leaves.
APPEARS IN	July.

Distribution

Widespread.

Life-history

The "cherry black fly" hatches from eggs in spring upon the cherry, and the lice breed throughout the spring and early summer. Flies appear in July and vanish to some other plant returning in autumn and producing the wingless sexual females and winged males.

2. Economic

Trees Attacked

Cherries; also red and black currants.

Frequency of Pest

Common.

Nature of Attack

The aphis infests the shoots and leaves, and sometimes destroys these and kills the shoots. The leaves usually curl up, but not invariably. Much sticky honey-dew is produced which may ruin the fruit, as it forms a medium for the growth of black fungus which soon covers it.

Degree of Damage

Variable.

Fig. 170. Black Cherry Aphis, magnified. Inset natural size.

Preventive Measures

Autumnal spraying kills the sexual females and prevents egg-laying. NICOTINE[1] and SOFT SOAP[2] or PARAFFIN EMULSION[3] may be used. Thick LIME[4] wash applied in the spring prevents the successful hatching of the eggs (see page 274).

Remedies

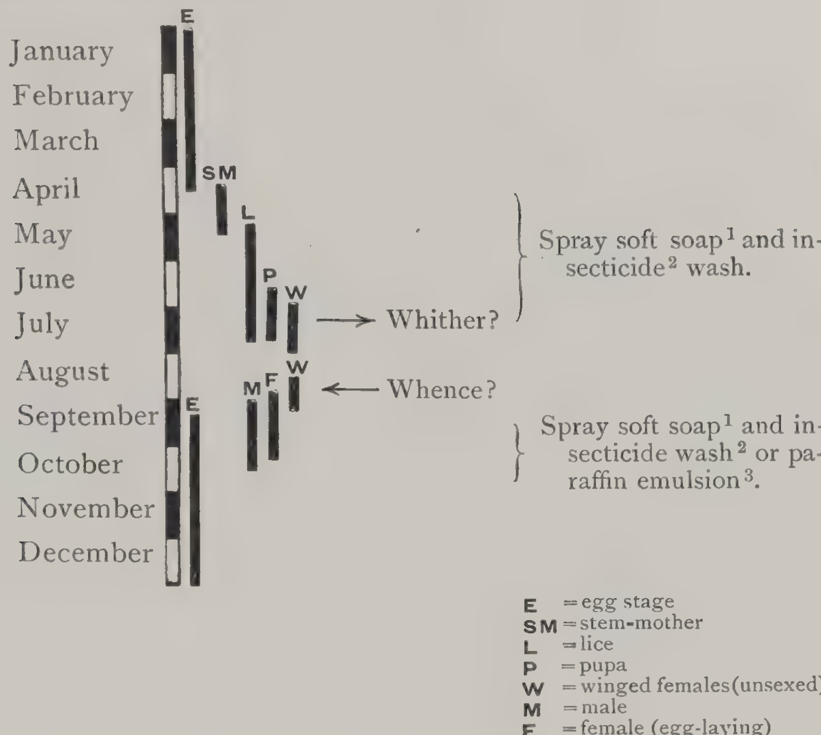
Spraying with a good SOFT SOAP[2] and INSECTICIDE[5] wash (e.g. NICOTINE[1]) is a pretty certain cure. 4—5 ozs. of nicotine to 100 gallons is required and plenty of soft soap.

Remarks

A high pressure on the spraying pump (upwards of 100 lbs. per square inch) is necessary. Adjustment of nozzle as fig. 250 page 634.

[1] See page 436. [2] See page 452. [3] See page 417.
See page 428. [5] See page 390.

Calendar of Treatment



LEAF-BUNCHING CURRANT APHIS

Name *Aphis grossulariæ*[4] Family *Aphidæ* Order *Hemiptera*

1. General

Description

Adult Insect (winged unsexed female)

REMARKS. This is apparently one of the migratory aphides, the only forms on the currant being the (unsexed) winged females, wingless females, and pupæ. Obviously the flies come from and return to some other host-plant, but this is at present unknown.

[1] See page 452. [2] See page 390. [3] See page 417. [4] Kaltenbach.

APPEARS IN	Middle to end May.
DURATION.	Till middle July.
Ova (Eggs)	Unknown.

Fig. 171. Leaf-bunching Currant Aphis (*grossulariæ*) magnified (× 10). Inset natural size.

Larva or "Louse"

SIZE.	Fairly large.
COLOUR.	Very dark green.
LOCATION.	Inside tuft of young leaves at top of plant.
APPEARS IN	May.
DURATION.	Till end of June.
REMARKS.	"Horns" pale and outline of body "pimply" (from above) due to a row of small projections at the sides of the abdomen (see fig. 171).

Distribution

Common

Life-history

This aphis appears on the currants and gooseberries about the middle or end of May and continues usually till the middle of July. Winged forms then appear and leave the plants, flying probably to the *Guelder Rose*[1]. It is easily distinguished by its very dark colour, and by the characteristic bunching together of the top leaves of the plant.

2. Economic

Trees Attacked

Red and black currants and gooseberries.

Frequency of Pest

Common.

Nature of Attack

The aphis causes a dense bunching together, or clustering, of the top leaves, and practically prevents the growth of the plant. The aphis is thus completely hidden and protected.

Duration of Attack

May to July.

Degree of Damage

Serious.

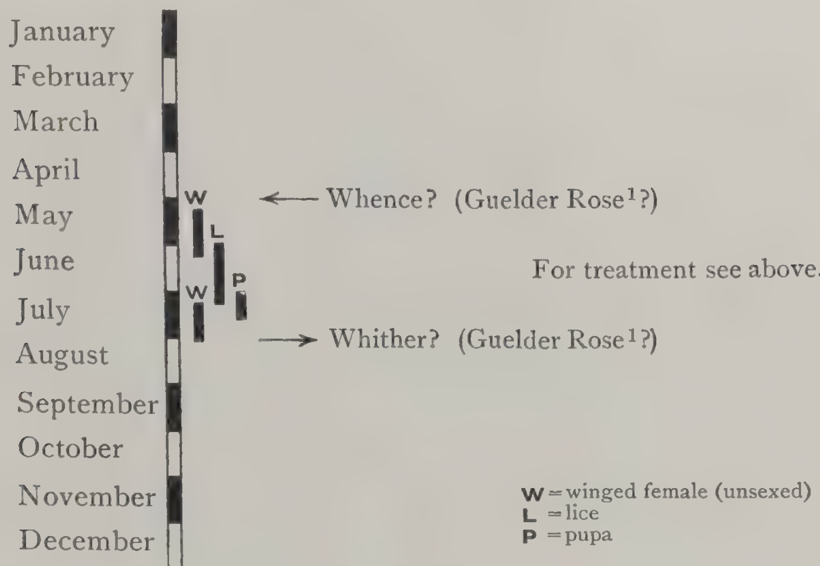
Remedies

1. It has been suggested to dip the bunched heads of the plants into pails of paraffin emulsion. It is however doubtful if by this method the air could be removed sufficiently to actually wet the aphis.
2. A method which the author has found very successful, is to tie thin bladders of skin or rubber round the heads, passing into these hydrocyanic acid gas or nicotine fumes, and then securing by tying round the stem and leaving for several hours.

[1] Theobald, *Journ. Econ. Biol.* VII. 1912, page 100.

Fig. 172. Showing the leaf-bunching effect produced by Aphis. ($\frac{3}{4}$ natural size.)

Calendar of Treatment



LEAF-BLISTER CURRANT APHIS

Name *Myzus ribis*[2] Family *Aphidæ* Order *Hemiptera*

1. General

Description

Adult Insect (winged unsexed female)

APPEARANCE.	Greenish-yellow or yellow: head darker: eyes red.
REMARKS.	Only the winged sexless females (*c*) and lice appear on the currants. The plant on which the egg-laying occurs is not at present known.
APPEARS IN	June to August.
Ova (Eggs)	Unknown.

[1] Professor Theobald has practically demonstrated that this is the normal host-plant.
[2] Linnæus.

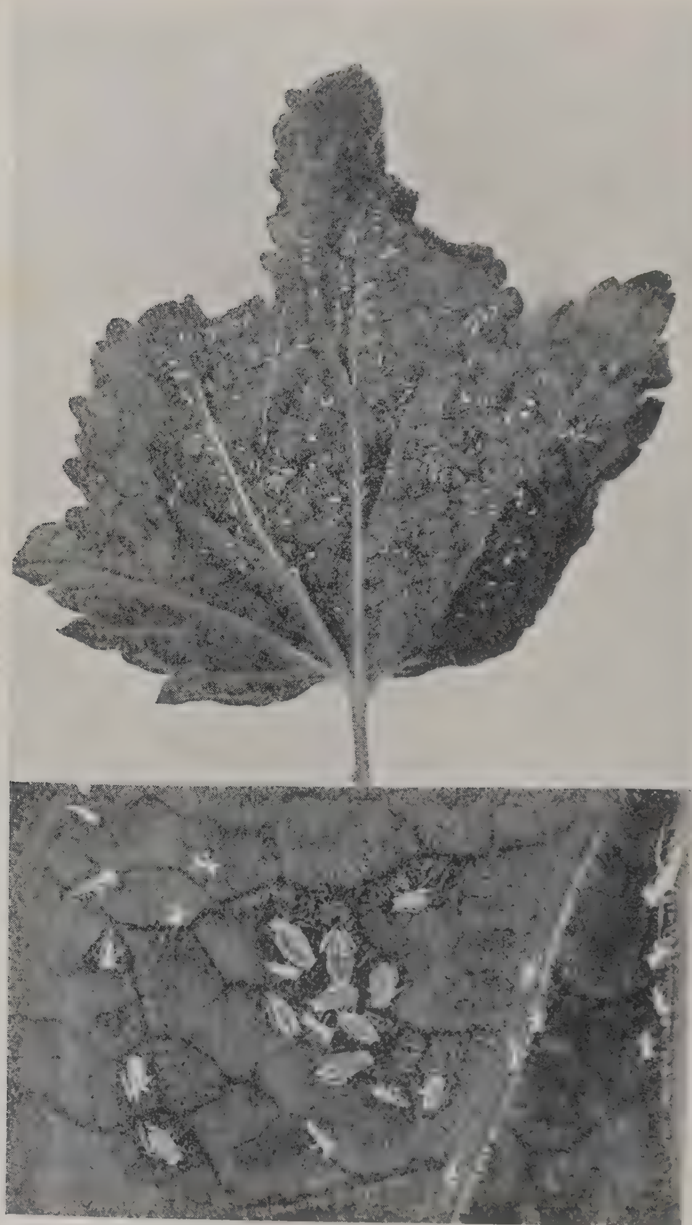


Fig. 173. Leaf-blister Currant Aphis on currant leaf. Natural size and magnified.

Larva or "Louse"

APPEARANCE.	Almost transparent.
COLOUR.	Yellow or yellowish-green.
LOCATION.	In the red blisters of the leaves.
APPEARS IN	About middle of May.
DURATION.	Till end July.

Distribution

Widespread.

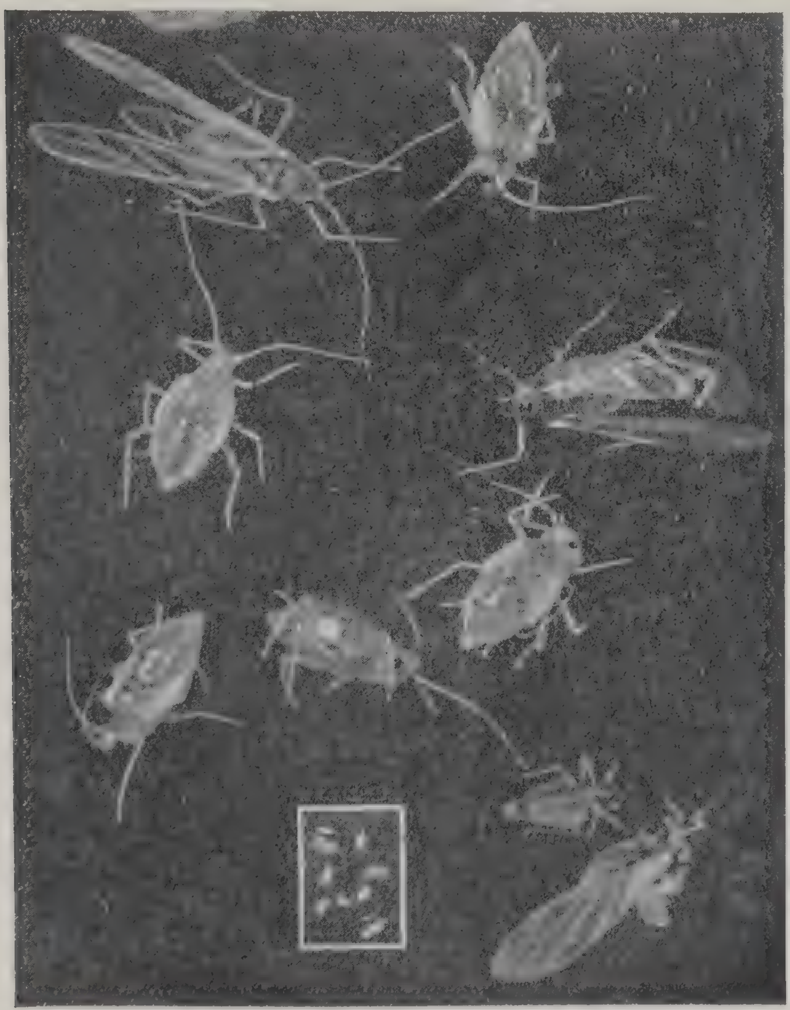


Fig. 174. Currant Aphides magnified (× 10) and natural size (inset) from interior of blisters on leaf.

Life-history

The lice appear, sheltering under the red blisters, in May and remain till August. The plant on which the sexual insects are produced, and the eggs laid, is not yet known.

Remarks

Some "lady-birds" and hover-fly larvæ feed upon the aphis and keep it in check, but too late to prevent weakening of the plant.

Fig. 175. Blisters produced on currant leaves in which the aphis shelters.

2. Economic

Trees Attacked

Currants, gooseberries.

Frequency of Pest

Very common.

Nature of Attack

The yellowish lice swarm on the inside of the red blisters on the leaves, and seriously weaken the plant.

Degree of Damage

Variable.

Natural Enemies

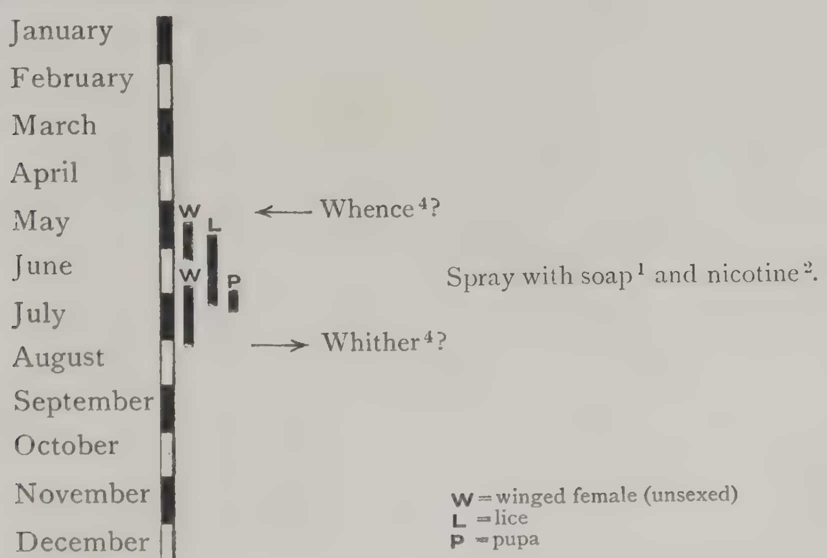
Some "lady-birds" and hover-fly larvæ feed upon the aphis and help to control it.

Remedies

No preventive remedies are possible, since it is not known where the aphides lay their eggs, and in what plant the sexual forms appear.

1. Spray with SOFT SOAP[1] and NICOTINE[2] wash. This is by far the most successful wash to use. Plenty of soap should be used and if a ready mixed wash is employed, growers should insist on a high soap content (see page 454).
2. PARAFFIN EMULSION[3] is good, but less effective.

Calendar of Treatment



[1] See page 452. [2] See page 436. [3] See page 417.
[4] Probably Horehound and other plants of the natural order *Labiatæ* (Theobald).

CURRANT-LETTUCE APHIS

Name *Rhopalosiphum lactucæ*[1] Family *Aphidæ*
Order *Hemiptera*

1. General

Description

Adult Insect

APPEARANCE.	Shiny green. Thorax, head and feelers black; rest green or greenish-yellow.
REMARKS.	The usual series of adults are produced, viz. stem-mothers ("Queens") (*a*), wingless females (*b*), winged females (*c*), sexual wingless females (*d*), males (*e*). The winged females fly to lettuce, sow-thistle, and other plants, breed there during the summer and return in the autumn to the currants.
APPEARS IN	(*a*) April, (*b*) May, (*c*) May—June, (*d*) and (*e*) September—October.

Ova (Eggs)

APPEARANCE.	Oval.
COLOUR.	Brown.
ARRANGEMENT.	In groups.
LOCATION.	On or under bark of twigs.
APPEAR IN	Autumn.
HATCH IN	April.
DURATION.	Throughout the winter.

Larva or "Louse"

SIZE.	Variable according to age.
COLOUR.	Green or yellowish-green: eyes red.
LOCATION.	Under the red blisters of the leaves.
APPEARS.	During the spring and early summer.
REMARKS.	The blisters are not apparently caused primarily by the aphides.

[1] Kaltenbach.

Nymph (Pupa)

APPEARANCE.	With wing-buds.
COLOUR.	Green or yellowish-green.
LOCATION.	On leaves.
APPEARS.	Irregularly in summer.
DURATION.	Few days.
REMARKS.	Gives rise to the winged sexless female (*c*).

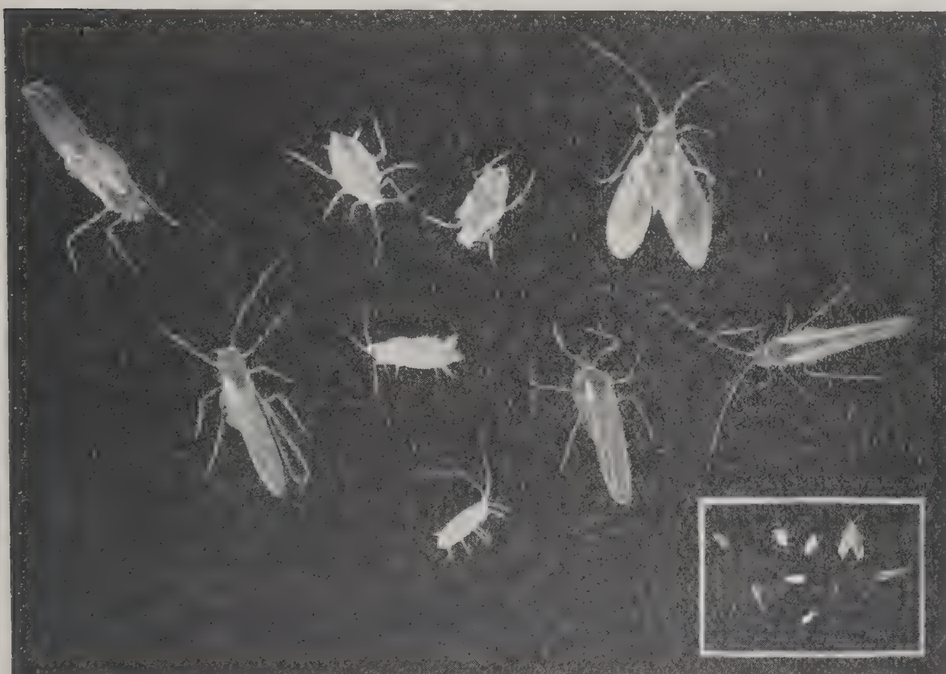


Fig. 176. Currant-lettuce Aphis, magnified. Inset natural size.

Distribution

Widespread.

Remarks

The winged flies (*c*) produced in summer from the pupæ visit other plants, chiefly lettuces, sow-thistles, etc.

2. Economic

Trees Attacked

Currants (red, black and white), gooseberries.

Frequency of Pest

Common.

Nature of Attack

The aphis feeds on the under surface of the leaves inside the red blisters; like the following variety, it is not actually responsible for these, but makes use of the protection so afforded.

Degree of Damage

Variable.

Preventive Measures

Hard pruning and destruction of the cuttings will destroy many eggs.

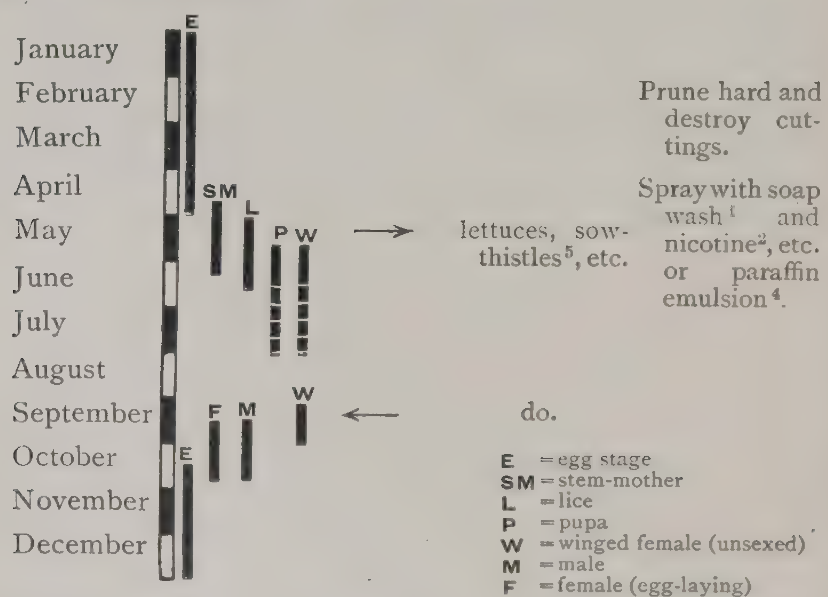
Remedies

Spray early, directly the aphis is seen, with SOFT SOAP[1] wash and NICOTINE[2] (or other insecticide[3]), dilute PARAFFIN EMULSION[4], or an efficient compound wash.

Remarks on Remedies

A type of spray nozzle must be employed to reach the under surfaces of the leaves.

Calendar of Treatment



[1] See page 452. [2] See page 436. [3] See page 390.
[4] See page 417. [5] Theobald.

HOP APHIS (Hop-damson aphis), Hop "blight," Hop "fly," etc.

Name *Phorodon humuli*[1] Family *Aphidæ* Order *Hemiptera*

1. General

Description

Adult Insect

(*a*) STEM-MOTHER (wingless), derived from eggs on *damson trees* and from a few which pass the winter on or near *hops*. Bears living young.

Appearance—oval, yellowish-green, eyes red, legs green.

Remarks—special formation at *base of feelers* is distinguishing feature of this aphis (see fig. 177).

(*b*) WINGLESS FEMALE (unsexed), derived from (*a*) and from (*c* 1). Bears living young on damsons in spring.

Appearance—as for (*a*).

Duration—about 3 generations on *damsons* in spring, and many generations on *hops* in summer.

(*c*) WINGED FEMALE (unsexed), derived from pupæ from (*b*) in (1) spring on *damsons* flying to hops, and (2) summer on *hops* flying to damsons.

Appearance—green with black heads and spots, eyes reddish. The second form (2) on hops is larger than (1).

Appears in—(1) spring on damsons, (2) summer on hops.

(*d*) WINGLESS SEXUAL FEMALE, derived from (*c* 2) on the *damsons only*.

Appearance—small, white at first, green later.

Appears in—autumn on damsons.

(*e*) WINGED MALE. In this species the male is *winged* contrary to most aphides. It is derived from (*c* 2) and usually occurs on the damsons only.

Appearance—light green with patches of greenish-brown, *very long feelers*.

Appears in—autumn on damsons and rarely from hops.

[1] Schrenk.

Ova (Eggs)

Appearance.	Shiny—spindle shaped.
Colour.	Black.
Arrangement.	In heaps sticking together.
Location.	At *junction* of small buds and boughs.
Appear in	Late autumn.
Hatching period.	Spring.
Duration.	Throughout winter.

Fig. 177. Hop Aphis. Various forms, magnified (× 10). Inset natural size.

Larva or "Louse"

Colour.	White to yellowish-green according to age.
Location.	On damsons and hops.
Appears	During spring (damsons) or summer (hops).

Nymph (Pupa)

Appearance.	With wing-buds developed.
Colour.	Greenish-yellow with brown wing-buds.
Location.	(1) on damsons, (2) on hops.
Appears in	Spring on damsons: late summer on hops.
Duration.	Variable.

Distribution

Occurs wherever hops are grown.

Life-history

The life-history has been fully worked out, and is very complicated, there being two host-plants (damson and hop) and at least eight different forms, viz. two wingless females (unsexed), two winged females (unsexed), two pupæ, one male winged and one sexual female wingless.

In brief, the aphis produced from eggs on the damson flies to the hops, and after propagating there during the summer, further winged forms appear and return to the damsons.

Remarks

The exact history can be best studied from the diagram on page 312. It takes place as follows:

1. Eggs are laid on the twigs of the damson in autumn.
2. These hatch in April and produce "stem-mothers" (*a*).
3. The stem-mothers produce three generations of lice growing into sexless females (wingless) (*b*).
4. In May and later, winged females (*c* 1) are produced which fly to the hops and there bear living young.
5. Several generations of sexless females (wingless) (*b*) are produced on the hops.
6. Towards the end of the summer, winged females appear on the hops (*c* 2) and fly back to the damsons.

7. From the winged females, wingless sexual females (*d*) and *winged* males (*e*) are produced, and on fertilisation, eggs are laid on the damsons. In addition, some stem-mothers (*a*) pass the winter under crevices and rubbish near the hops.

This aphis is distinguished from all other pests by the curious tooth-like projection at the base of the feelers.

Fig. 178. Badly infested hop leaf. Natural size and magnified.

The flight of the winged females in early summer from the damsons to the hops, and the return in the autumn, appears to be mainly directed by the prevalent winds so that only a small fraction are usually able to reach their objective. "Swarms" of these winged females often occur in hop districts (even in the towns) after a bad "blight."

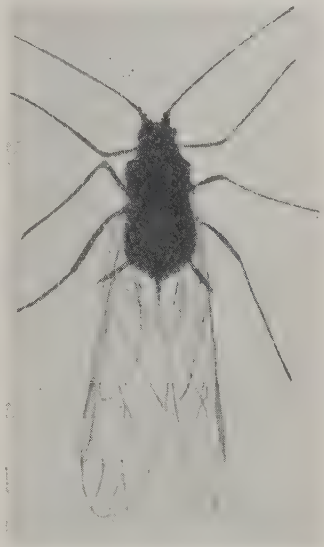


Fig. 179. Hop-damson Aphis from damson. Highly magnified.

The effect of weather conditions on the hop aphis is very marked. Thus, a bad attack may clear off in a few days—almost hours, if the weather is unsuitable (cold, heavy rain, thunderstorms) and, conversely, the aphides increase with marvellous rapidity under favourable conditions (warm bright days).

2. Economic

Trees Attacked

Hops, damsons.

Frequency of Pest

Very common, occurring in varying degrees of severity each year in the hop districts (Kent, Worcester, Hereford, Sussex, etc.).

Nature of Attack

The aphis lives on the young leaves of the damson, and later upon the hops, often persisting until the formation of the flower (burr) and then doing great havoc to its growth.

Duration of Attack

Damsons—spring.

Hops—throughout summer.

Degree of Damage

The damsons are much weakened by the attack especially if young.

The damage to hops is very variable: in bad attacks the

plants are entirely withered and blackened. Since it increases with such rapidity there is always a grave risk to the crop unless spraying is at once carried out. Further, as the cost of cultivation of hops is relatively high, the failure of even a proportion of the crop may result in serious financial loss. It is therefore good policy to spray as soon as any sign of aphis appears and to keep spraying till the hops are quite free.

Natural Enemies

The most important are the lady-birds[1] and their larvæ or "niggers."

Preventive Measures

1. Spray the damsons with thick LIME WASH[2] just previous to the swelling of the buds and so prevent successful hatching out of the eggs. Late spraying with lime—even up to the appearance of the flower trusses—has not been found injurious (see fig. 245, page 618).
2. Spray the damsons in the early spring with a SOFT SOAP[3] and INSECTICIDE[4] wash, and so prevent migration to the hops.

This is another instance of the desirability of compulsory spraying or for co-operation. If damsons were everywhere sprayed in the neighbourhood of hop gardens, subsequent "blight" on the hops would be much mitigated. It is useless for one or two growers to spray if they are surrounded by neighbours who do not trouble.

Remedies

Fortunately, the hop aphis does not curl up the leaves, and so is easily accessible to sprays.

SOFT SOAP[3] is the basis of all hop-sprays, and pure potash soap is preferable to the soda-soft-soap substitute[5] sold during the war. Growers should specify freedom from *caustic*[6] and *carbonate of soda*[7]. In addition it is best, though not absolutely necessary, to add a proportion of an EFFICIENT INSECTICIDE[4], such as nicotine[8]. (Quassia[9] is less powerful but of proved value. (For further information on spraying see Section IX.)

[1] See page 469. [2] See page 428. [3] See page 452. [4] See page 390.
[5] See page 454. [6] See page 453. [7] See page 453. [8] See page 436.
[9] See page 446.

Fig. 180. Appearance of a hop garden badly infested with aphis.

Remarks on Remedies

It is essential to use *plenty of soap* so that the aphis shall be *thoroughly wet.* Especially is this the case when soap is used alone. The hardness of the water should be known[1], and this allowed for in making up the wash (see remarks on pages 454, 455, 458, 460).

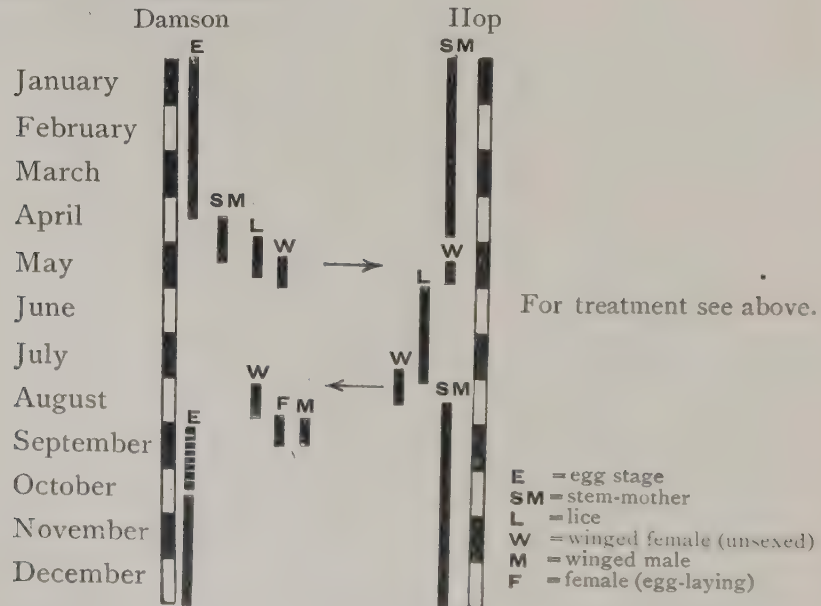
It is important to use only the *best makes* of soft soap on hops, since they are notably delicate and likely to be scorched or injured with inferior materials.

Early in the season, when the hops are small, a rather fine spray should be used. Later, when the leaves are well grown, a fairly coarse, powerful spray, with a good pressure behind it, is essential. Nozzle adjustment as fig. 250, page 634.

Caution

Towards the end of the season, when the "burr" or "pin" is forming, a too powerful spray should be avoided, as the "pin" is very delicate and may be damaged. At this time also it is well to reduce the percentage of insecticide used in the wash, and to avoid an excess of soft soap, even if this is of the highest quality.

Calendar of Treatment



[1] One well-known firm analyses samples of water free for growers.

PLUM LEAF-CURLING APHIS[1]

Name *Aphis pruni*[2] Family *Aphidæ* Order *Hemiptera.*

1. General

Description

Adult Insect

The usual series of adults appear in the normal order:

(*a*) STEM-MOTHER. Dull purple.—On young leaves (from eggs) in early spring.

(*b*) WINGLESS FEMALE (unsexed). Green to olive brown—on leaves, which rapidly curl up. Produced during spring and summer.

(*c*) WINGED FEMALE (unsexed). Vivid green with black head, thorax and feelers.—It flies away in June and leaves the plums, returning in autumn, and giving rise to:

(*d*) SEXUAL FEMALE (wingless). Small, pale green.—Autumn.

(*e*) WINGED MALE. Small, dull yellow to black.—Autumn.

Remarks.—A large amount of sticky "honey-dew" is secreted on the leaves by the aphis, and the leaves rapidly curl up when the young lice appear.

Ova (Eggs)

APPEARANCE.	Small, shiny.
COLOUR.	Black.
ARRANGEMENT.	Singly or in groups.
LOCATION.	On twigs and at base of buds.
APPEAR IN	October or November.
HATCHING PERIOD.	Early spring.
DURATION.	Throughout the winter.

Larva or "Louse"

COLOUR.	Green (brownish later) feelers, "horns" and legs brown.
LOCATION.	Inside tightly curled leaves.
APPEARS IN	Early spring.
DURATION.	Throughout spring and early summer.
REMARKS.	Much sticky "honey-dew" is secreted on the leaves, and some "meal."

[1] See also Appendix XII, p. 710. [2] Fabricius.

Fig. 181. Plum Leaf-curling Aphis. ($\frac{3}{4}$ natural size.)

Nymph (Pupa)

APPEARANCE.	With wing-buds.
COLOUR.	Greenish-yellow.
LOCATION.	In the curled leaves.
APPEARS IN	June or July.
DURATION.	Few days.
REMARKS.	Change into the winged sexless females (*c*) which fly away and return in autumn (see above).

Distribution

Widespread.

Life-history

Similar to the other aphides. The eggs hatch out very early in spring, and the lice produced, at first green, grow into the large purple "mother queens." These produce lice at a surprising rate, and the leaves commence rapidly to curl up. The winged flies appearing in June or July fly away to some unknown plant and return in autumn, giving rise to sexual forms which produce the eggs.

2. Economic

Trees Attacked

Plums, damsons, and occasionally apples, peaches and apricots.

Frequency of Pest

Common.

Nature of Attack

The edges of the leaves gradually curl up and roll tightly round, due to the attack of the aphis. In bad attacks the leaves soon die, and the young fruits fall.

The aphis attacks damsons severely, and is distinguished from the Hop-damson aphis by the absence of the tooth-like projection at the base of the feelers (see fig. 179).

Duration of Attack

Spring and early summer.

Degree of Damage

Often very severe.

Preventive Measures

A LIME COVER WASH[1] applied in March before buds swell has been found effective in preventing successful hatching of the eggs. This may be applied quite late on without injury.

Remedies

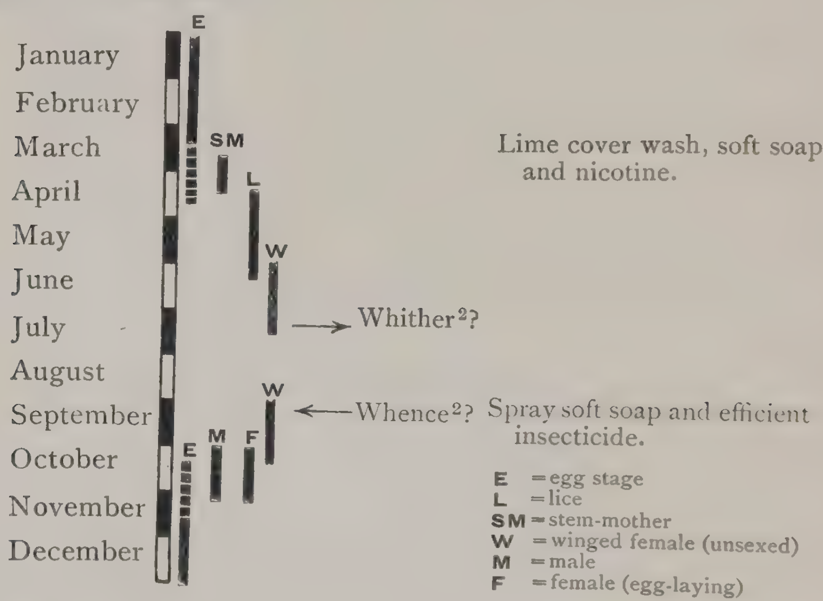
Spraying is pretty certain to be successful if done thoroughly at the right time *before the curling of the leaves.* This should be not later than the fall of the blossom, and preferably before it opens. The stem-mothers are thus killed.

SOFT SOAP and an EFFICIENT INSECTICIDE are necessary ingredients of the wash, and these may be made up or a compound wash of known efficiency employed.

Remarks on Remedies

Plenty of soap should be used, and a high pressure of the spraying pump maintained. Adjustment of nozzle as fig. 250, page 634.

Calendar of Treatment



[1] See page 428.

[2] Probably various weeds, such as cow-weed, etc. (Theobald).

MEALY PLUM APHIS

Name *Hyalopterus pruni*[1] Family *Aphidæ* Order *Hemiptera*

1. General

Description

Adult Insect

Only two of the five standard types are at present known :

(*a*) STEM-MOTHER (from egg). Unknown.

(*b*) WINGLESS FEMALE (unsexed), occurs on plum leaves during August, and bears living young.
Appearance—light green, covered thickly with meal.
Duration—from June to September.

(*c*) WINGED FEMALE (unsexed). These fly to the plums from some unknown plant (possibly grasses or reeds). They produce living young on the plum leaves.
In autumn, the same form occurs, and flies off again to the other breeding plant.
Appearance—bright yellowish green, with dark green markings on thorax and abdomen. Slightly mealy.
Occurs—in June (1) and September (2).

(*d*) WINGLESS EGG-LAYING FEMALE. Unknown.

(*e*) MALE. Unknown.

Ova (Eggs) Unknown.

Larva or Louse

COLOUR.	Light green covered with meal.
LOCATION.	Crowded together on under surface of leaf.
APPEARS IN	June.
DURATION.	Till September.
REMARKS.	The aphides do not usually curl the leaves but plenty of "honey-dew" is produced.

Distribution

Widespread.

[1] Fabricius.

Fig. 182. Mealy Plum Aphides. Magnified (× 10). Inset natural size.

Life-history

The aphis appears as winged sexless females about June or July. Lice are produced alive on the plum leaves, which are not curled by the attack, and great numbers appear on the under surface of the leaves, sometimes completely covering them. Much grey meal appears on the surface of the bodies and a large amount of honey-dew is secreted.

Towards August, flies are again produced, and the aphis leaves the plum and flies to some unknown breeding plant (possibly grasses).

2. Economic

Trees Attacked

Plums of all kinds, also damsons, peaches, nectarines, etc.

Susceptible Varieties

Worst on Victorias and Czars.

Frequency of Pest

Common.

Nature of Attack

It infests the lower surface of the leaves in great numbers, and weakens the plant.

Degree of Damage

Not so serious as the leaf-curling aphis, as it seldom attacks the plums before midsummer.

Remedies

1. SOFT SOAP[1] and NICOTINE[2], or an efficient insecticide.
2. WEAK PARAFFIN[3] emulsion and LIVER OF SULPHUR[4].

Remarks on Remedies

The soft soap and nicotine wash is preferable, but, owing to the mealy covering being difficult to penetrate, about 50 per cent. excess ($\frac{1}{2}$ as much again) of soft soap over the usual amount required for aphis is necessary (see pages 438, 454).

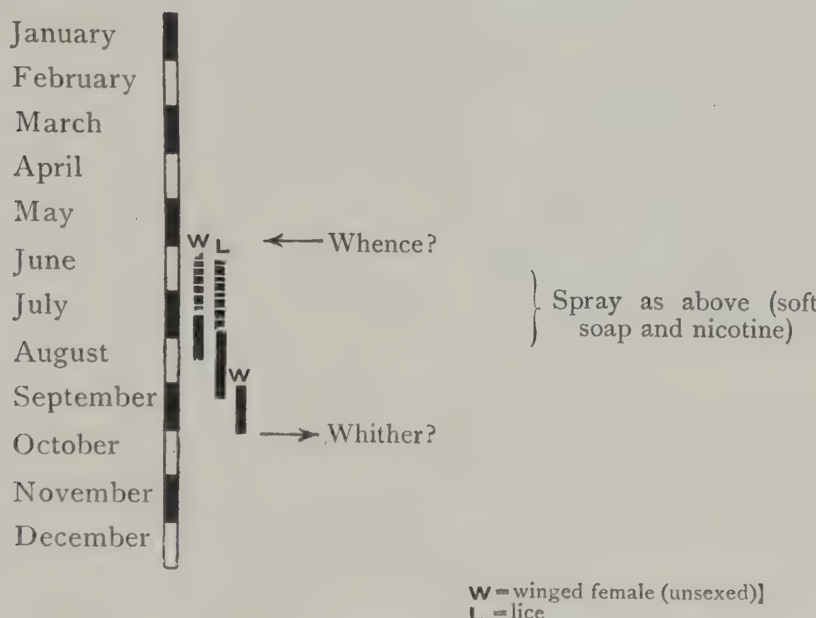
[1] See page 452.
[2] See page 436.
[3] See page 417.
[4] See pages 431, 624.

Fig. 183. Plum leaves badly infested with the Mealy Plum Aphis.

About 5 ozs. of nicotine for 100 galls. of wash is a suitable quantity. If the paraffin emulsion is used, care must be taken that it is freshly prepared and that a thorough emulsion is produced (see page 418).

A medium fine spray should be used, the adjustable nozzle being screwed so as to give a middle position (see page 632 and figs. 250 to 253). A high pump-pressure is essential.

Calendar of Treatment



RASPBERRY APHIS.

Name *Amphonophora rubi*[1] Class *Aphididæ* Order *Hemiptera*

1. General

Description

Adult Insect

All the usual forms occur :

(*a*) STEM-MOTHER (from egg), produces living young on the leaves. Appearance—shiny green, hairy, eyes red, legs and horns long.

(*b*) WINGLESS FEMALE (unsexed). As above (*a*).

[1] Kaltenbach.

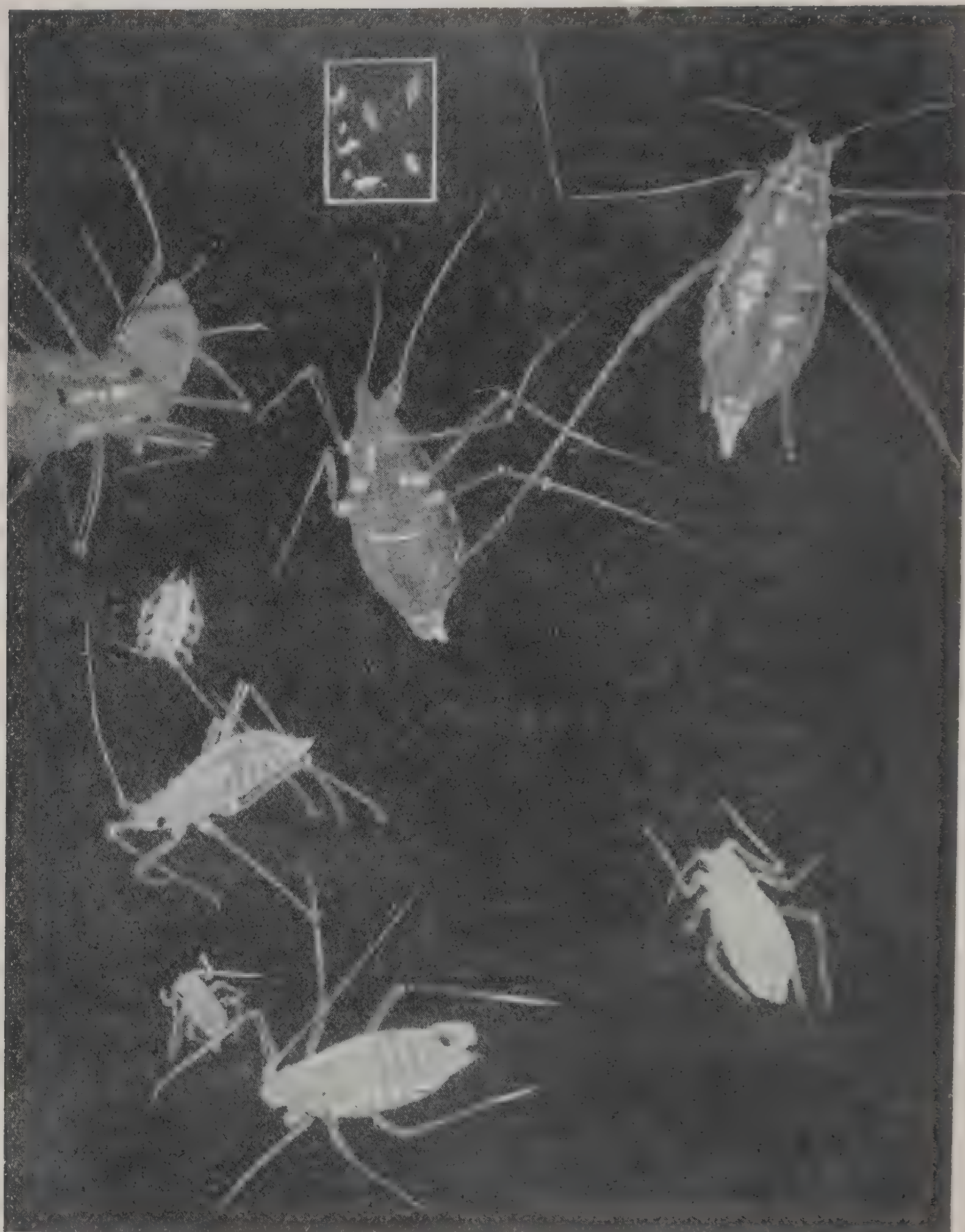


Fig. 184. Raspberry Aphides. Various stages of growth. Magnified (× 10). Inset, natural size.

(*c*) Winged female (unsexed). 1. Summer brood fly away. 2. Autumn brood return and produce sexual males and females.
Appearance—green all over, legs and feelers long.

(*d*) Wingless egg-laying female (sexual), product of (*c*) 2 above.
Appearance—oval, green, long feelers and legs: occurs in late autumn.

(*e*) Male (winged), product of (*c*) 2 above.
Appearance—green with black head, large wings and legs. Occurs with (*d*) in autumn.

Ova (Eggs)

Colour.	Shiny black.
Location.	On and under rind of canes and on brambles.
Appear in	Late autumn.
Hatching period.	Spring.
Duration.	Throughout the winter.

Larva or "Louse"

Description as for "stem-mother" (*a*) above.

Distribution

Widely distributed.

Life-history

The aphis goes through the usual changes, and disappears from the raspberries in late summer, reappearing in autumn. The other food plant is at present unknown.

2. Economic

Trees Attacked

Raspberries, blackberries, brambles.

Frequency of Pest

Fairly common.

Nature of Attack

The aphides attack the leaves in the usual manner, but they do not cause them to curl to any extent.

Degree of Damage

Not usually serious. If in large numbers serious weakening of the plant may occur and the crop suffer.

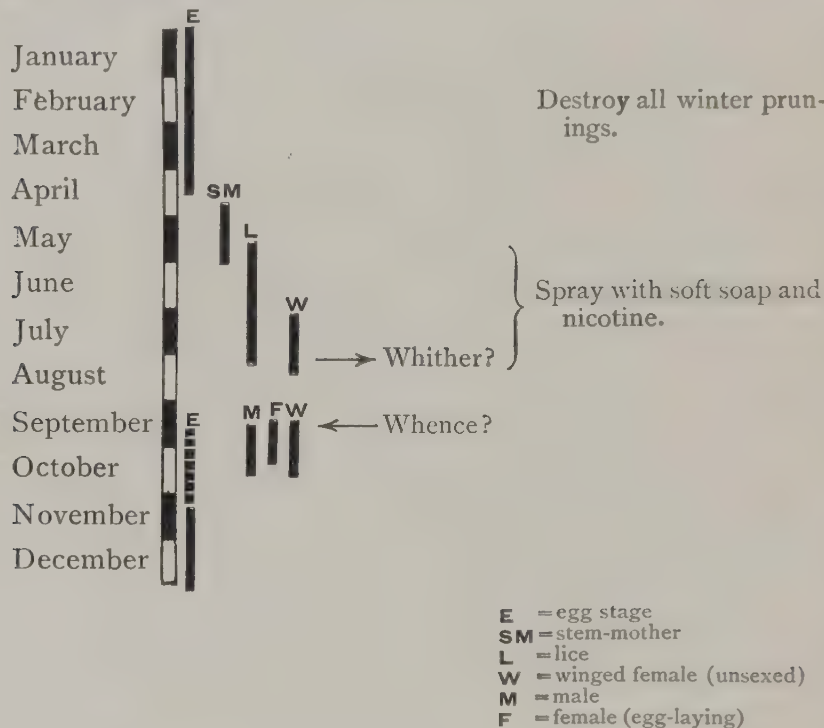
Preventive Measure

Destroy all the winter prunings.

Remedies

Spray the raspberries with SOFT SOAP[1] and NICOTINE[2] or other efficient insecticide[3] whenever the aphis occurs in harmful numbers.

Calendar of Treatment



[1] See page 452. [2] See page 436. [3] See page 390.

STRAWBERRY APHIS

Name *Myzus fragariella*[1] Class *Aphididæ*
Order *Hemiptera*

1. General

Description

Adult Insect

All the usual forms occur:

(*a*) STEM-MOTHER (from egg), living young produced on the strawberry leaves.
Appearance—bright green or yellowish, head green, eyes black, horns and feelers long and thin.

(*b*) WINGLESS FEMALE (unsexed), as for (*a*) produces living young throughout summer.

(*c*) WINGED FEMALE (unsexed), does *not* appear to leave the strawberries in the late summer.
Appearance—head and feelers green, eyes brown, horns black.

(*d*) EGG-LAYING FEMALE (sexual), occurs in late autumn and lays eggs on the leaves after fertilisation by the

(*e*) MALE (sexual).

Ova (Eggs)

COLOUR.	Black shiny.
LOCATION.	On leaves near veins.
APPEAR IN	Late autumn.
HATCHING PERIOD.	Spring.
DURATION.	Throughout winter.

Distribution

Mainly West of England, so far.

Life-history

Follows the usual course, the aphis apparently existing throughout all its stages on the strawberry. Eggs hatch out in spring and the lice appear till end of summer. Flies occur and the sexual forms in late autumn when egg-laying takes place on the leaves.

[1] Theobald.

2. Economic

Trees Attacked

Strawberries (and wild strawberries).

Frequency of Pest

Not common.

Nature of Attack

The aphis attacks the under-surface of the leaves in the usual manner.

Degree of Damage

Not serious unless in large numbers.

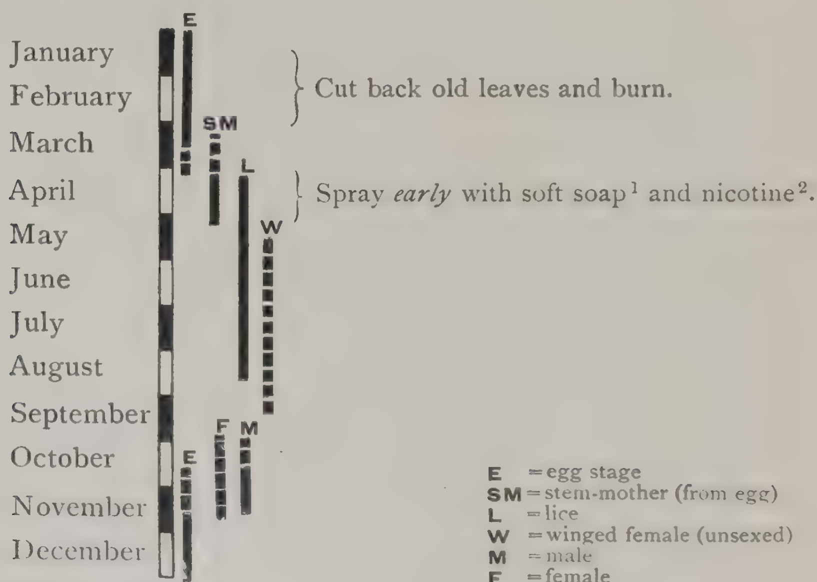
Preventive Measures

Cut back all old leaves in winter and burn them. Many eggs will thus be destroyed.

Remedies

Spray in early spring (beginning of April) with SOFT SOAP[1] and NICOTINE[2] or other efficient insecticide[3]. This will kill the stem-mothers. If left later, spraying becomes proportionately more difficult on account of the thick leafage.

Calendar of Treatment



[1] See page 452. [2] See page 436. [3] See page 390.

WOOLLY APHIS ("American Blight")

Name *Eriosoma lanigera*[1] Class *Aphididæ*
Order *Hemiptera*

1. General

Description

Adult Insect

Forms occur as follows:

(*a*) MOTHER-QUEEN. This is either the hibernating form (hiding in winter in crevices or below ground on the roots) or the adult from the eggs. They produce living young throughout spring and summer.
Colour—purple brown, with much "wool."
Shape—oval.
Appears in—spring and throughout the year.

(*b*) WINGLESS FEMALE (unsexed), the adult product of (*a*). Produces living young continuously.
Appearance—as (*a*): much "wool" secreted.
Location—on branches or roots.

(*c*) WINGED FEMALE (unsexed). *Uncommon.* Produced from pupæ very irregularly during July to September.
Appearance—chocolate brown in colour, distinguished by the arrangement of the veins on the wings.
Location—above ground only.

(*d*) WINGLESS EGG-LAYING FEMALE. *Very rare.* Produced at long intervals in autumn.
Appearance—very minute: only $\frac{3}{1000}$ inch in size. Yellowish red colour and without mouth. Deposits one egg and dies, shielding it with her body.
Location—above ground only.

(*e*) WINGLESS MALE. *Very rare.* As for (*d*).
Appearance—as for (*d*).
Location—above ground only.

[1] Hausmann.

Ova (Eggs)

APPEARANCE.	Minute: oval.
COLOUR.	Shiny black.
ARRANGEMENT.	Singly under dead body of female (*d*).
LOCATION.	In crevices of bark near ground.
APPEAR IN	Autumn.
HATCHING PERIOD.	Spring.
DURATION.	Throughout winter.
REMARKS.	Comparatively rare.

Fig. 185. Woolly Aphides—detached lice. Magnified (× 5) and natural size (inset).

Larva or "Louse"

APPEARANCE.	Naked at first, later covered over with "wool."
COLOUR.	Yellowish: then purple.
LOCATION.	(1) On branches, shoots, trunk, etc.; (2) below ground on roots.

DURATION.	(1) Spring and summer above ground; (2) all the year round below ground.

Nymph

LOCATION.	Above ground on branches, etc.
APPEARS IN	Summer.
REMARKS.	Not common.

Distribution

Practically world-wide.

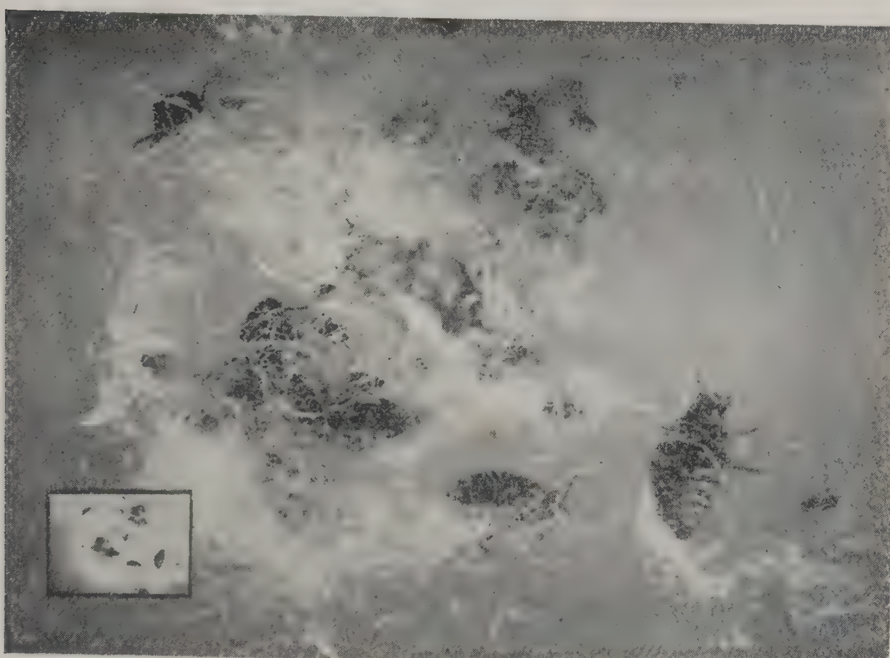


Fig. 186. Woolly Aphides, showing "wool." Magnified ($\times 6$) and natural size (inset).

Life-history

This aphis is peculiar in living both ABOVE AND BELOW ground, and to pass the winter the above-ground individuals descend to the roots and attack these, in company with those which have remained there throughout the summer. In fact, there is probably a constant migration occurring between the roots and branches. In addition, some of the adults spend the winter in crevices of the bark, protected by their WOOLLY COVERING. This is the other

peculiar feature of this remarkable insect. The very young are naked, but soon secrete strands of the wool and often to such an extent that it hangs down below the branches.

The mother-queen (*a*) gives rise to living young, which reproduce throughout the year. Only rarely are the pupæ and winged insects (*c*) produced: and only very rarely are the sexual forms seen (in autumn), although these may escape observation on account of their minute size. It would appear that the development of the root form has almost obliterated egg-laying as a means of carrying the species on over the winter.

The insects infest all parts of the trees, but only rarely the leaves and fruit. Its activities appear to be absolutely unaffected by even extreme cold.

The normal host-tree is the *elm*.

2. Economic

Trees Attacked

Apples and occasionally pears.

Immune Varieties

Apples on the *Northern Sky* and *Majetin* stocks are said to be free from attack.

Frequency of Pest

Increasingly common in all parts, but particularly in the West of England.

Symptoms of Attack

The appearance of the white "wool" in crevices of the branches and trunk very quickly reveals its presence.

Nature of Attack

1. The trunk and boughs are attacked (rarely the leaves and blossoms or fruit), the aphis penetrating to the inner bark and living upon the sap.
2. The roots are attacked in a similar manner. This is the worst form.

Duration of Attack

1. On the branches, etc., mainly in the spring and summer.
2. On the roots, all the year round.

Fig. 187. Woolly Aphis attack on an apple tree, and cankerous swelling. (See also fig. 162).

Degree of Damage

1. The tree is exhausted by the LOSS OF SAP both above and below ground. Young trees are often killed.
2. LARGE SWELLINGS and deformities are produced on both branches and roots which after a time dry up and crack.
3. The inner surfaces are exposed to FUNGUS ATTACK, particularly *canker*.

Natural Enemies

The most useful are birds, especially the TITS.

Lady-birds devour them and several other insects attack them, but the economic results are trifling.

Preventive Measures

Plant immune varieties. There are about a dozen blight proof New Zealand varieties obtainable.

Fumigate all nursery stock with HYDROCYANIC ACID GAS[1] before planting. A thorough treatment should kill all eggs as well as insects and insure freedom from the disease.

Remedies

The above- and below-ground lice must be destroyed at the SAME TIME, otherwise one form will infest the other portion of the plant.

1. Spray *in winter* with strong CAUSTIC PARAFFIN EMULSION[2] or CAUSTIC ALKALI WASH[3] alone. Strong LIME-SULPHUR[4] washing should also be of benefit if thoroughly carried out.
2. *Simultaneously* inject CARBON BISULPHIDE[5] into the soil to kill below-ground variety.
3. Wash in the summer with strong SOAP[6] and NICOTINE[7] (5—6 oz. per 100 gall. wash), using in addition a small quantity of paraffin properly emulsified[8] (not exceeding 2 galls. per 100 of the wash).
4. Banding the trees about the middle of May was effective in catching many migrating aphides[9].

   In all cases a *coarse* and *powerful* spray is required. This necessitates a high pressure on the pump, and an adjustment of the nozzle as fig. 250, page 634.

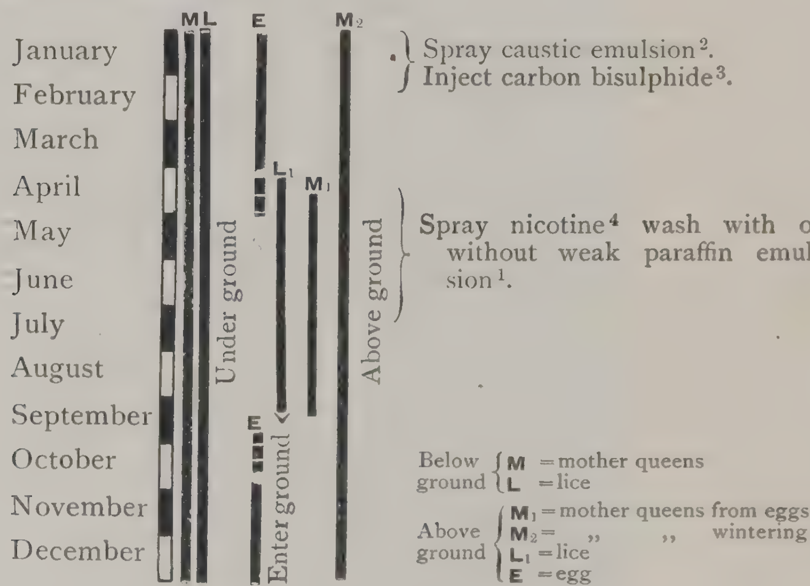
[1] See page 423. [2] See page 420. [3] See page 413.
[4] See page 612. [5] See page 410. [6] See page 452.
[7] See page 436. [8] See page 418. [9] See page 632.

Fig. 188. Root form of Woolly Aphis showing damage to main root, and aphides *in situ*. (About $\frac{1}{3}$ size.)

Remarks on Remedies

1. The carbon bisulphide injection must be made before April, and preferably in dry weather. (For other details see page 410.)
2. Generally speaking it is useless to employ insecticides for ummer spraying other than nicotine and soft soap unless the ‘wool” is first removed, as insufficient penetration will be effected. It should, however, be mentioned that Professor Lees has found that a properly prepared emulsion[1] containing 2 per cent. of soft soap and 2 per cent. paraffin oil can be made to penetrate the wool and kill the aphides.

Calendar of Treatment



[1] See page 420. [2] See page 420.
[3] See page 410. [4] See page 436.

SCALE INSECTS

CHAPTER 21

Scale Insects (Coccidæ)

These form a very curious group of insects. Like the aphides they suck the plant juices by means of jointed beaks. Unlike any other member of the order, however, they are stationary once the young forms have selected their position. They are covered with a hard, adhesive *scale*, and under this protection the insect lives, performs its functions and then dies and shrivels up, leaving the eggs which it has laid under the protection of the scale. The male insects are winged, but they are rather rare. Fertile eggs apparently are produced for some generations without the assistance of the male insect.

The scale insect is killed by treatment with strong caustic emulsion in the winter. Lime-sulphur is also of proved benefit. Summer treatment is only of use if the young insects are hatched and have not come to rest.

MUSSEL SCALE (Oyster-shell bark louse)

Name *Lepidosaphes ulmi* Class *Coccidæ* Order *Hemiptera*

1. General

Description

Adult Insect

	Female	Male
SIZE.	$\frac{1}{6}$ to $\frac{1}{8}$ inch.	About $\frac{1}{10}$ inch across wings.
APPEARANCE.	Without legs, wings, or feelers under "scale."	With a single pair of wings, long legs and feelers, and long sexual fertilising tube.
COLOUR (BODY).	Whitish.	
„ (SCALE).	Dark brown or grey.	

	Female	Male
Location.	Adhering to bark of trunks and branches.	On trees.
Appears in	Late summer.	Late summer.
Duration.	Produces eggs under scale and dies in winter.	Dies after fertilising the female.
Progression.	Stationary.	Crawls and flies.
Remarks.	The female can apparently produce fertile eggs without fertilisation in many cases.	

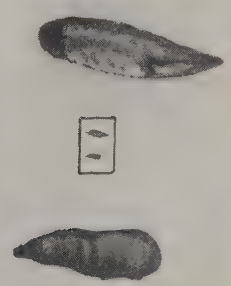


Fig. 199. Mussel Scale, upper and under surfaces, showing eggs. Magnified. Inset, natural size.

Ova (Eggs)

Appearance.	Minute, oval specks.
Colour.	Grey.
Arrangement.	In a mass under the scale, alongside shrivelled body of female.
Location.	On trunk or twigs.
Appear in	Winter.
Hatching period.	June.
Duration.	Throughout late winter and spring.

Larva or "Louse"

Size.	Very small.
Appearance.	With six legs and two feelers.
Colour.	Light grey: appear as white specks on tree.

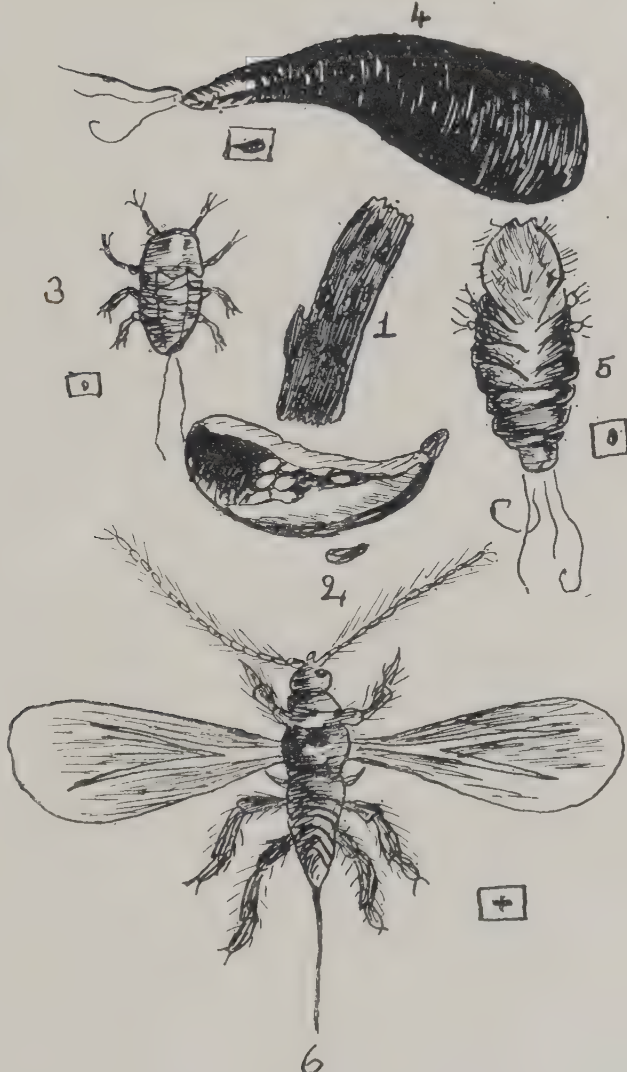


Fig. 200. Diagram of various stages of Mussel Scale insect. 1, scale on twig. 2, reverse side of scale, showing eggs, enlarged and natural size. 3, final nymph stage, enlarged and natural size. 4, female scale, enlarged and natural size. 5, insect removed from shell, enlarged and natural size. 6, male insect, enlarged and natural size.

LOCATION.	On all parts of tree.
PROGRESSION.	Actively crawling at first, then stationary.
APPEARS IN	June.
NUMBER OF MOULTS.	One: changes into adult male or female.
DURATION.	Few days or weeks.

Pupa No definite pupal stage exists.

Distribution

World-wide.

Life-history

The life-history of this insect is very curious and interesting.

The scales are very commonly seen on most fruit trees, especially in old orchards. If one of these scales be examined in spring or late winter, it will be found firmly attached to the trunk or branch, and when carefully detached by the point of a knife, the under surface magnified, a mass of grey dust—the eggs—will be seen together with the shrivelled body of the female insect.

If other scales on the tree be kept in close observation, the eggs will be seen to hatch out (in about June) into very minute, active mites, provided with feelers and six legs. These crawl all over the trees, becoming covered with a greyish white powder.

Finally they come to a standstill, and, plunging their long beaks into the tissue of the tree, cast their skin, and commence the formation of the "SCALE," which gradually envelopes their bodies. Usually they change into the female form, the scale of which is larger and narrower than that of the male. In this case, legs, feelers, etc. are shed, and the eggs formed in the body of the female are forced out under the protection of the scale, and the female dies and gradually shrivels up, the scale remaining as before externally.

In the case of the larva producing the male insect, it settles down as before, but does not produce a scale of the same character as the female. A kind of pupa stage ensues, and the male issues forth as a complete winged insect (see fig. 200). The long tube at the end of the body is now used in inserting under the scales to fertilise the females, after which the insect dies.

It does not appear to be necessary to fertilise the female upon all occasions in order to produce fertile eggs.

Fig. 201. Mussel Scale on apple tree ($\frac{3}{4}$ natural size), also same magnified (inset).

2. Economic

Trees Attacked

Almost all fruit, e.g. apple, pear, plum, damson, cherry, currant, peach, etc.

Frequency of Pest

Very common.

Nature of Attack

Feeding upon the sap of the plant, this insect exhausts the tree and is most injurious to its health.

The normal "breathing processes" of the tree are also interfered with by the close incrustation of the scales.

The trunk and branches are mainly attacked, but scales are also found upon the leaves and fruit.

Degree of Damage

Young trees are frequently so thickly attacked as to be killed.

Preventive Measures

The most important of these is the *treatment of nursery stock.* It is in this way that the disease has been spread, in the past, to all parts of the world. Stock should be *guaranteed free*; or fumigated with HYDROCYANIC ACID GAS[1].

Natural Enemies

Certain Chalcid flies destroy the scales, and the tits devour them greedily, but these cannot be relied upon to deal with an attack.

Remedies

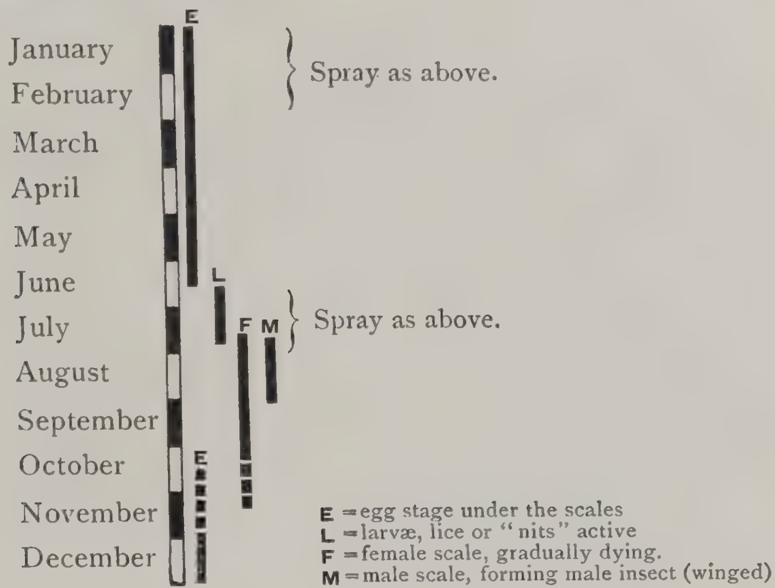
Spray in the *winter* with either of the following:

1. PARAFFIN EMULSION[2] with or without CAUSTIC SODA[3].
2. CAUSTIC SODA[3] alone ($2\frac{1}{4}$ per cent.).
3. LIME-SULPHUR[4] (full winter strength).

In summer, spray with weak PARAFFIN EMULSION[2], with SOFT SOAP[5] and NICOTINE[6], or with 1 in 30 (S.G. 1·01) LIME-SULPHUR[4] late in May or early June to kill the newly hatched larvæ.

[1] See page 423. [2] See page 417. [3] See page 420.
[4] See page 612. [5] See page 452. [6] See page 436.

Calendar of Treatment



BROWN SCALE

Name *Lecanium persicæ* Class *Coccidæ* Order *Hemiptera*

1. General

Description

Adult Insect (Female)

SIZE.	About $\frac{1}{8}$ inch.
APPEARANCE.	Rounded: old scales much grooved.
COLOUR.	Brownish yellow.
APPEARS	About April or May.
REMARKS.	Two or three broods may also occur in one year. The MALE has not been found in this country, and probably appears only once in several generations.

Ova (Eggs)

APPEARANCE.	Minute, dust-like, amongst white threads.
LOCATION.	Under the scales on young shoots.

APPEAR	About May, occasionally in the autumn.
HATCH IN	June.
DURATION.	About 1 month.

Larva or "Louse"

COLOUR.	Yellowish or reddish, with fine threads.
LOCATION.	On all parts of the plant.
PROGRESSION.	Active.
APPEARS IN	June (or later).
DURATION.	Usually throughout winter (in dormant condition).

Life-history

Similar to that of the Mussel Scale (page 358), but the winter is generally passed in the immature larval condition, the egg-laying taking place in late spring.

2. Economic

Trees Attacked

Currant, gooseberry, also raspberry, plum.

Frequency of Pest

Fairly common.

Nature of Attack

The insects suck the sap from the young shoots, preventing growth and sometimes killing the shoot.

Preventive Measure

Fresh stock should be fumigated with HYDROCYANIC ACID GAS[1].

Natural Enemies

Numerous, especially lady-bird, beetles and tits: but of little practical use.

Remedies

Spray with strong LIME-SULPHUR[2] in the winter.
This is a specific for this particular insect and cannot fail to kill if properly applied.

[1] See page 423. [2] See page 612.

Fig. 202. Diagram of Brown Scale. 1, larva. 2, scale on branch. 3, female. Enlarged (× 2).

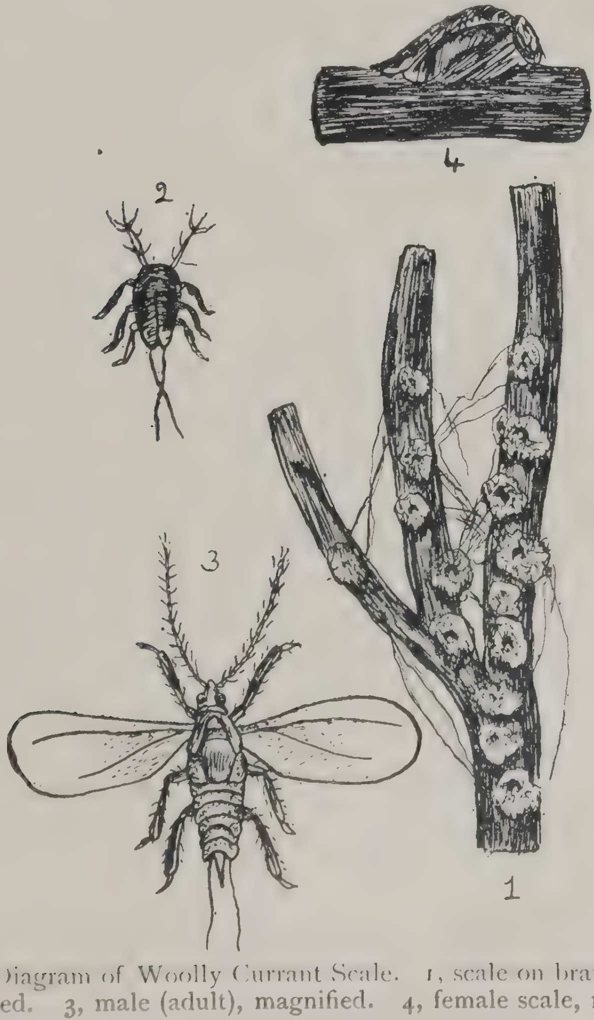
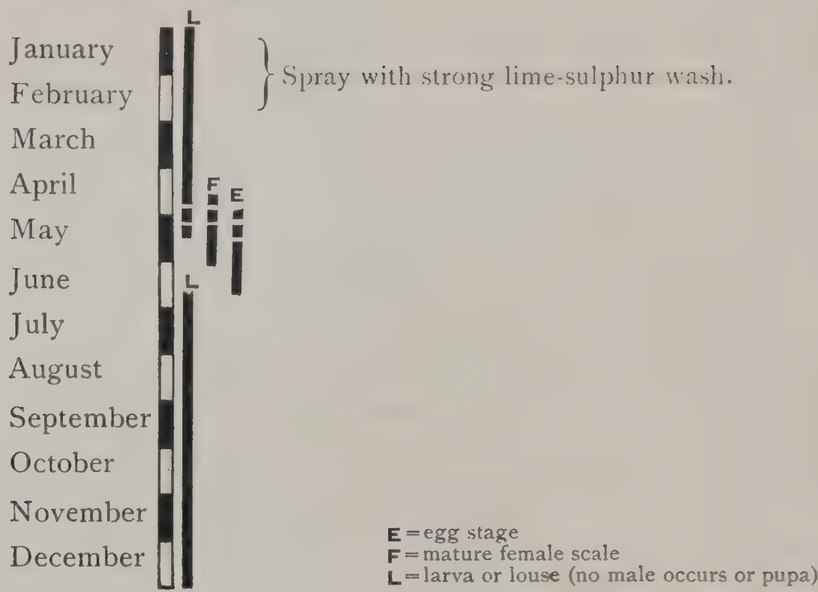


Fig. 203. Diagram of Woolly Currant Scale. 1, scale on branch. 2, larva, magnified. 3, male (adult), magnified. 4, female scale, magnified.

Calendar of Treatment



WOOLLY CURRANT SCALE

This very curious scale occurs occasionally on currant bushes in this country. The appearance during summer is very characteristic; white woolly pads and hairs cover the bushes and extend from branch to branch.

The larvæ hatch out in June and are minute orange-coloured lice, very active. They disperse over the plant and select the young shoots and here anchor and become hardened. A cushion of "wool" appears in early spring and lifts one end of the scale up. Loose strands blow about among the branches. On this wool the eggs are laid and the female then dies and shrivels up. The eggs become distributed by wind and by birds. A large amount of sticky "honey-dew" is produced in the spring. (See fig. 203, page 363.)

Treatment etc. as for Brown Scale (page 362).

MITES AND SPIDERS

(*ARACHNOIDEA*)

CHAPTER 22

Mites

These are not of course insects, but belong to the same order as spiders. Propagation is by egg-laying, but there is nothing corresponding to the *pupal stage* of an insect. The young usually varies slightly from the adult.

The Gall Mites infest buds and leaves, while the so-called "spiders" suck the juices of plants in a similar manner to the aphis, and treatment follows the same lines (see chapter 18).

BIG BUD (Currant gall mite)

Name *Eriophyes ribis* Class *Acarina*
Order *Arachnoidea*

1. General

Description

Adult Mite

SIZE.	Very minute (barely $\frac{1}{100}$ inch long).
APPEARANCE.	Semi-transparent, glistening: thin cylindrical shape, with few long bristles (two at tail-end).
COLOUR.	White or faintly greenish.
LEGS.	Four at end of body, around the mouth.
MOUTH.	Sucking and chewing (with jaws and sucker).
PROGRESSION.	By means of a claw at tail-end the mite can traverse the outside of the buds.

LOCATION.	(1) In great numbers in the buds apparently all the year round. (2) During April and May, occur also on outside of buds or on stems and flowers. (3) Possibly some enter the soil for a time.
APPEARS IN	Most of the year in the buds.
DURATION.	Mites apparently die in the dead buds, but their actual length of life is undetermined.

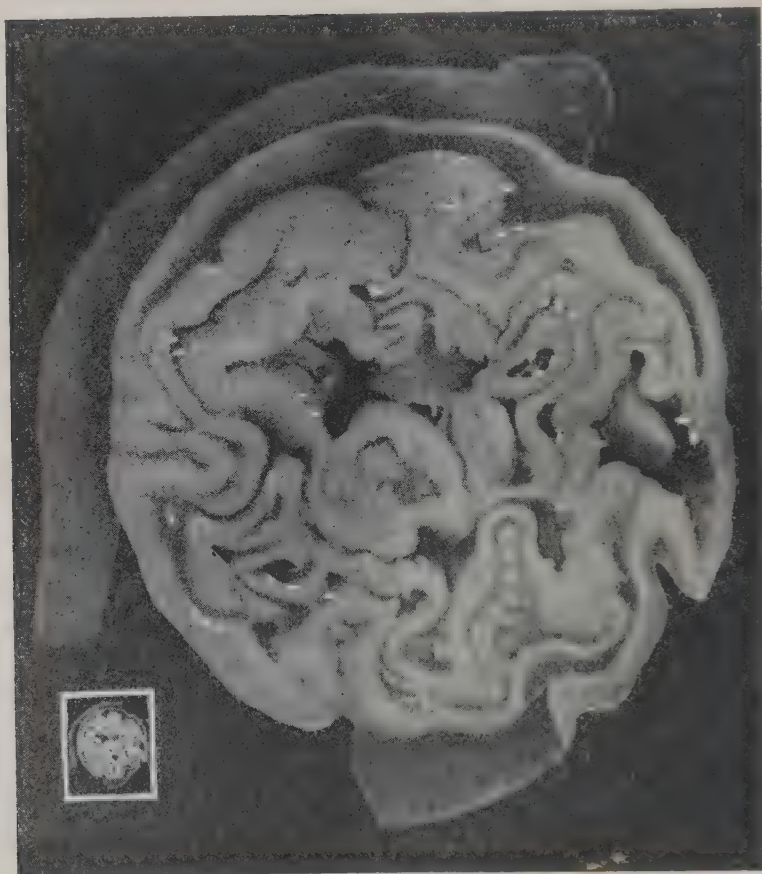


Fig. 204. Cut through a bud (radial section) showing mites. Magnified and natural size (inset).

Ova (Eggs)

SIZE.	Occur as a whitish powder in the buds.
APPEARANCE.	When magnified, spherical, pale green, transparent.

LOCATION.	In thousands inside the swollen buds.
APPEAR	All the year round.
DURATION.	Very variable.

Young

These vary in size and appearance and several moults appear to take place before the adult stage is reached.

Distribution

Widespread in England.

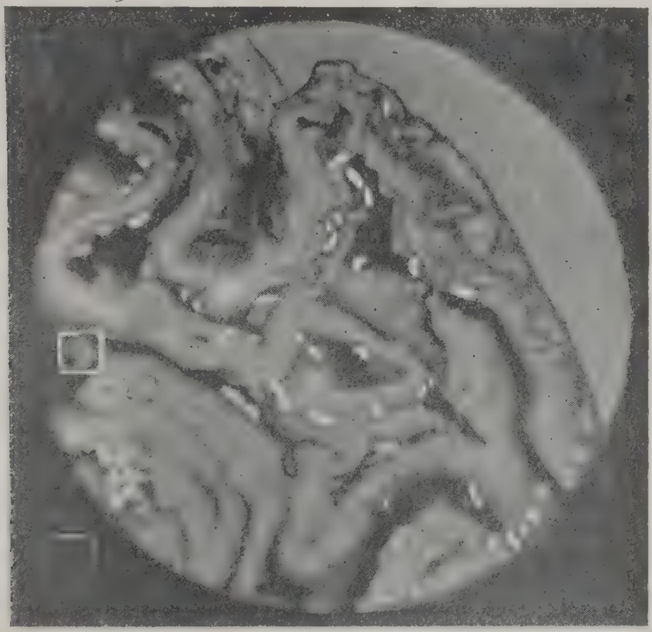


Fig. 205. As fig. 204, but more highly magnified.

Life-history

The full life-history of this mite has not yet been traced.

The mites occur in the swollen buds apparently at most times of the year, together with many eggs.

Owing to the fact that they still appear in diseased buds when the plant has been entirely cut down and the roots cleansed, it is probable that some of the mites also enter the ground and re-infest the plant.

In April and May, when some of the buds burst, mites crawl over the plant by means of the claws at their tail-end.

The disease is distributed by the agency of wind, insects. clothing, and especially by cuttings from diseased stock.

Remarks

Healthy bushes in a plantation are infected from neighbouring plants by the migration of the mites in March and April, and once infected, the bush will be completely covered with "big buds" in the following season.

As regards "nettle-head" or "reversion" in currants, see Appendix, page 704.

2. Economic

Trees Attacked

Currants.

Susceptible Varieties

Many "immune" varieties have been produced, only to become attacked after longer or shorter intervals[1].

Frequency of Pest

Common in most parts of the country.

Nature of Attack

The buds, instead of appearing conical and healthy, swell up and become bloated and mealy in character.

If the attacked buds open, no fruit is as a rule produced.

Generally the buds turn brown and die during the summer.

Degree of Damage

Very serious once infection has taken place.

Preventive Measures

1. Insist upon healthy stock from the nurseryman.
2. Immerse cuttings in water at 115° F. for ten minutes before planting, or in cold water for some days.
3. Plant *strong growing varieties*.

Remedies

1. Hand pick swollen buds on their first appearance. It is advisable also to remove the buds *above and below* the infested ones, as these usually contain mites[2].

[1] Seabrook's black variety is however apparently more resistant. This appears to be not because it is immune from attack, but because the attacked bud dies and so the mites soon perish.

[2] Theobald.

The plantation should be gone carefully through twice a year, and the infested buds placed in baskets and burnt.

2. Spray in the winter with CARBOLIC ACID[1] 5 per cent. and SOFT SOAP[2] 10 per cent. This destroys the big buds by penetration and does not affect the healthy ones[3].

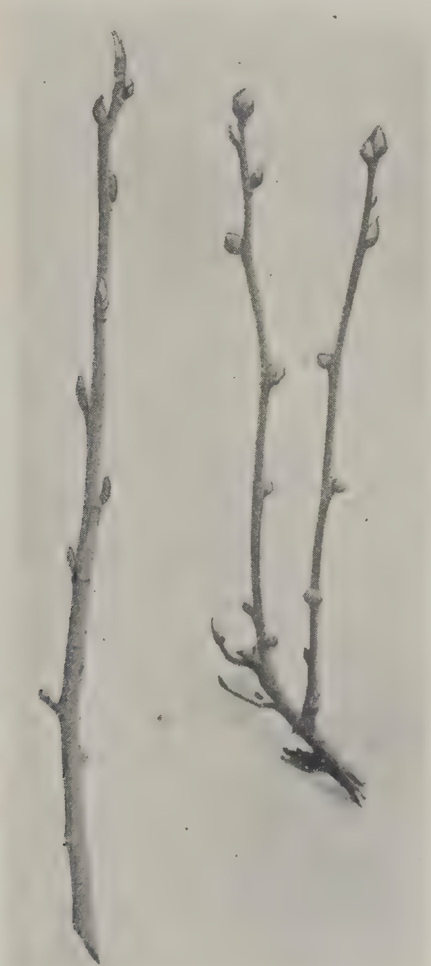


Fig. 206. Healthy (left) and attacked (right) stems of black currant, showing the "big buds."

3. Spray[3] when first leaves are as big as a sixpence (see No. 6, fig. 246, page 620) with extra strong LIME-SULPHUR (1 in 12 of 1·3 S.G.)[4].

[1] See page 410. [2] See page 452. [3] Lees. [4] See page 612.

LEAF BLISTER MITE

Name *Eriophyes pyri* Class *Acarina* Order *Arachnoidea*

1. General

Description

Adult Mite

SIZE.	Minute (about $\frac{1}{120}$ inch long).
APPEARANCE.	Cylindrical, with ring markings round body.
COLOUR.	White or pinkish.
LEGS. MOUTH. PROGRESSION.	Similar to the Currant *Big Bud* mite.
LOCATION.	Winter—under bud scales. Spring—entering leaves through stomata (breathing pores). Summer—in galls of leaves. Autumn—exposed on the trees and entering bud scales.

Ova (Eggs)

SIZE.	Minute.
APPEARANCE.	Oval, translucent white.
LOCATION.	In the tissue of the leaves.
HATCH IN	About a week.

Young

These resemble the adult: they lie in a curved position inside the galls on the leaves.

Distribution

World-wide. Not common in Britain till fairly recently.

Life-history

The winter stage is passed by the mites beneath the bud scales in groups of a score or so. In spring the young leaves of the bud are entered through the stomata (breathing pores).

Each mite produces a minute red blister, gradually increasing in size, and here eggs are deposited.

Later the newly hatched mites crawl out and enter fresh leaves continuously throughout the summer, the old galls darkening in colour.

In the autumn the mites leave the leaves and enter the buds under the scales.

2. Economic

Trees Attacked

Pear, apple.

Frequency of Pest

Becoming commoner.

Symptoms of Attack

The young opening leaves are observed to have minute red blisters (galls) which increase in size. The buds are also attacked. On the larger leaves the blisters may be very minute or reach $\frac{1}{4}$ inch in diameter, and may fall off.

Preventive Measure

The fumigation of all nursery stock with HYDROCYANIC ACID GAS[1] kills any mites in the buds.

Fig. 207. Diagram of Leaf Blister Mite. Greatly enlarged.

Remedies

1. Spray with strong LIME-SULPHUR[2] wash either in late autumn or early spring.
2. In small plots, hand pick and destroy affected leaves as early as possible.

[1] See page 423. [2] See page 612.

CHAPTER 23

Red Spiders

In general, the name applies to any small, red, spidery looking mite seen upon trees. Few of these however appear to be harmful. Thus the red spider (*Tenuipalpis glaber*) found in immense numbers on plum trees, which is familiar in the winter stage sometimes covering the shoots with the small round red eggs, is apparently quite harmless.

The Gooseberry Red Spider is another kind altogether (*Bryobia*) and is well known for its attack on the leaves of this plant. Various species of *Tetranychus* occur, and the one causing the most damage is the spider on the hops (*T. malvæ*). Treatment follows the same lines in all cases of spider attack.

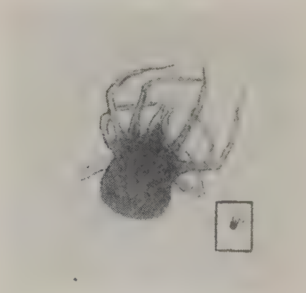


Fig. 208. A harmless variety of Red Spider. Enlarged and natural size (inset).

Fig. 209. Another common, and apparently harmless, variety of Red Spider. Enlarged and natural size (inset).

HOP RED SPIDER

Name *Tetranychus malvæ* Class *Acarina* Order *Arachnoidea*

1. General

Description

Adult Mite ("spider")

SIZE.	Female about $\frac{1}{25}$ inch long: male about half this.
APPEARANCE.	Oval, with four pairs of legs, armed with claws. Legs all about *equal in length.*
COLOUR.	Variable, reddish to greenish brown.
APPEARS IN	Spring.
LOCATION.	On undersurfaces of leaves amongst webs.
DURATION.	Till autumn.

Fig. 210. Hop Red Spider. Enlarged and natural size.

Ova (Eggs)

APPEARANCE.	Globular, pale yellow.
LOCATION.	Amongst and attached to webs on under surface of leaf.
APPEAR	Throughout summer.
DURATION.	Few days. Eggs laid in autumn probably last throughout winter.

Young

These are distinguished by having only six legs. They rapidly develop into adults.

Distribution

Widespread in the hop districts.

Life-history

The "spinning mites" (which are not true spiders) appear in spring, probably from eggs, though some may winter in crannies or under the ground.

They commence to spin fine webs on the under surfaces of the leaves, attaching these to the leaf hairs.

Eggs are laid and secured to the web, and these rapidly hatch out and the young spiders quickly become adult. This accounts for the rapid increase of the pest in suitable weather conditions. The spiders disappear in the late summer.

Remarks

Distinguished from the Gooseberry Red Spider by its front legs, and from the harmless variety on the plum by the fact of its web. (See pages 374, 377, 378.)

2. Economic

Plants attacked

Hops principally.

Frequency of Pest

Not infrequent.

Nature of Attack

The Hop Red Spider feeds upon the leaves, and causes these to appear greyish or marbled above and shiny beneath owing to the fine web. In severe attacks the hops are greatly weakened, and have a marked droop.

Conditions favouring attack

Dry sunny weather appears most favourable to attack, and the spider reproduces very rapidly under such conditions.

Degree of Damage

Occasionally serious.

Remedies

1. SULPHURING[1] the hops, as is carried out for mould, is a good remedy.
2. Spraying with SOFT SOAP[2] and either LIVER OF SULPHUR[3] or NICOTINE[4] or both will kill the spider. Plenty of soft soap must be used in order to penetrate the web.

[1] See page 626. [2] See page 452. [3] See pages 431, 624. [4] See page 436.

Remarks on Remedies

Care must be taken in using liver of sulphur on hops, especially in hot sunny weather, as it is very liable to scorch. (See page 625.)

GOOSEBERRY RED SPIDER

Name *Bryobia pretiosa* Class *Acarina* Order *Arachnoidea*

1. General

Description

Adult Spider

SIZE.	Small ($\frac{1}{30}$ inch adults) but larger than Hop Red Spider (*Tetranychus*).
COLOUR.	Usually bright red; but may be greyish or greenish.
APPEARANCE.	*Four pairs* of legs, front pair *very long*.
OCCURS IN	Early spring and throughout summer.
LOCATION.	On under surfaces of leaves, in early spring in crevices on the stem.
REMARKS.	This spider does not spin any web on the leaves.

Ova (Eggs)

SIZE.	Very minute (almost microscopic).
COLOUR.	Shiny red, with a few white hairs.
LOCATION.	On twigs and base of thorns.
APPEAR	From early spring onwards (till about June).
HATCH IN	4 to 5 days normally. Some eggs probably remain over winter.

Young Stage

APPEARANCE.	Small, semi-transparent, with *six legs*.
LOCATION.	On under surfaces of leaves.
MOULTS.	One; the mite is then an adult spider.
APPEARS	Throughout spring and early summer.
DURATION.	4 to 5 days.
REMARKS.	They are apparently able to reproduce in under 3 weeks from birth.

Distribution

Occurs wherever the gooseberry is grown.

Life-history

This spider probably passes the winter in the egg stage, and hatches out in early spring. Throughout spring and early summer eggs are laid which take only a few days to hatch and less than a month to produce the mature spider. The young hatching out from this egg have only *six legs*, while the adult has *eight legs*, the *front pair* being *very long*.

A remarkable fact about this spider is the extremely rapid rate at which increase can take place at times in suitable weather. Proably in these cases the immature stage is much shorter than normal.

Fig. 211. Diagram of Gooseberry Red Spider.
Enlarged and natural size.

Remarks

Distinguished from the red spider of hops and other fruit by its larger size, its long pair of front legs, and the absence of a web.

2. Economic

Trees Attacked

Gooseberries.

Frequency of Pest

Common.

Symptoms of Attack

The older leaves become marbled grey, or silvery in appearance, and the younger leaves are stunted in growth. In bud attacks, both leaves and blossoms and even the young fruits fall off.

Nature of Attack

The sap is drawn from the leaves by the suckers with which the spider is provided.

Duration of Attack

Variable: the spiders suddenly increase under suitable conditions, which appear to be warm, dry, sunny weather. They also are more active and do more harm under these weather conditions.

Degree of Damage

Serious, if in sufficient numbers.

Preventive Measure

Spraying with CAUSTIC SODA[1] during the winter has been found very beneficial.

Remedies

There are three substances of recognised value for Gooseberry Red Spider: NICOTINE, SULPHUR COMPOUNDS, PARAFFIN.

At times, one or other of these has failed in effect. It is therefore good practice to spray with all three, using a compound wash, made up as under, or bought specially prepared.

The best time to spray is early March, when a strong wash can be used. If sprayed later, the weaker mixture must be employed, and if there is *any doubt* as to the efficiency of the emulsion, it is best to leave out the paraffin altogether. This will however do no harm in February and early March.

Remarks on Remedies

1. *February and early March Spraying*: soft soap 15 lbs., paraffin oil 5 gallons, liver of sulphur 4 lbs., nicotine 4 ozs., per 100 gallons wash.
2. *Summer Spraying*: soft soap 15 lbs., paraffin oil 2 gallons, liver of sulphur 2 lbs., nicotine 5 ozs., per 100 gallons wash.

For directions in emulsifying the paraffin, see page 418.

Calendar of Treatment

The egg, young and adult stages overlap so much that it is useless to construct a calendar.

[1] See page 413.

EELWORM

(*VERMES*)

SNAILS AND SLUGS

(*MOLLUSCA*)

CHAPTER 24

Worms, Snails and Slugs

EELWORM

Name *Tylenchus devastatrix* Order *Vermes*

1. General

Description

Adult Worm

SIZE.	From $\frac{1}{30}$ to $\frac{1}{15}$ inch long.
APPEARANCE.	Very long, thread-like, and much twisted.
COLOUR.	Creamy white.
PROGRESSION.	By twisting movements of the body.
LOCATION.	In the roots of the infested plants, or in soil, manure, etc.

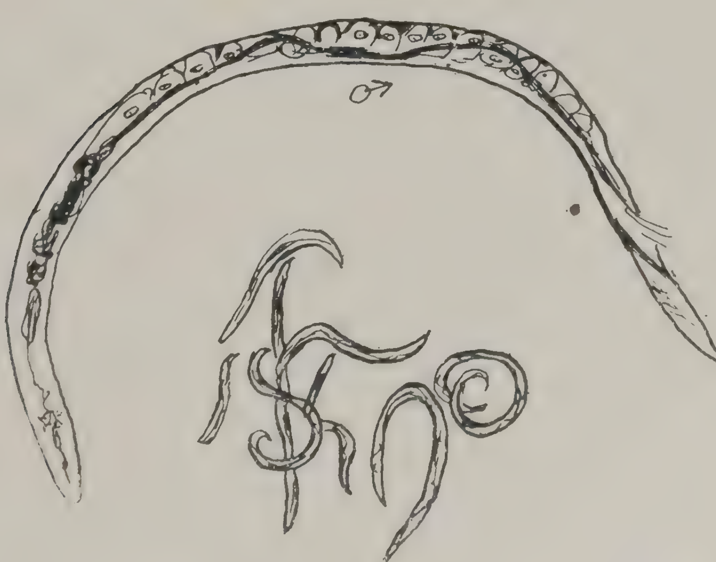


Fig. 212. Diagram of Strawberry Eelworm. Greatly enlarged. Also bunch of worms.

Ova (Eggs)

SIZE.	Minute, oval.
COLOUR.	White.
LOCATION.	In the infested roots.

Distribution

In most districts of England.

Life-history

The worms enter the roots from the soil, and cause them gradually to decay. They breed inside the root tissue, and on its death they enter the soil and attack neighbouring plants.

2. Economic

Plants Attacked

Many grasses and roots: amongst fruit, mainly strawberries.

Symptoms of Attack

The plants gradually fail and finally wither. No marked symptoms appear, and the roots must be carefully examined with a hand magnifier to detect the presence of the worm.

Remedies

The usual SOIL INSECTICIDES[1] should be watered into the ground surrounding the plants, and if these are badly attacked, they should be taken up and burnt.

SNAILS AND SLUGS

Name *Helix, various species, Limacidæ* Order *Mollusca*

1. General

Description

Adult

APPEARANCE, ETC.	Too well known to need description.
APPEAR	All the year.
DURATION.	Probably some years.
LOCATION.	Under stones, etc. in daytime: on the leaves of plants at night.
REMARKS.	Active after rain.

[1] See page 433.

Ova (Eggs)

ARRANGEMENT.	In heaps of 10 to 50 or more.
LOCATION.	In the soil.
APPEAR IN	Usually August to November.
HATCHING PERIOD.	2 to 3 weeks.

Distribution

Found universally in temperate climates.

Life-history

The slugs and snails are not all, or entirely, destructive to plants, as many feed upon worms and other slugs.

They are particularly active after rain. During the winter they hide in a dormant state under stones, debris, etc., living in some cases many years.

2. Economic

Plants Attacked

Strawberries are the chief sufferers, though most small plants are attacked.

Nature of Attack

Both the fruit and the leaves are eaten.

Natural Enemies

The thrush is the most beneficial bird, devouring many hundreds of snails and slugs.

Remedies

1. Pen ducks amongst the plants: these devour the slugs greedily.
2. Dress the ground with soot and lime.
3. Sprinkle SOIL INSECTICIDES[1] over the surface.

[1] See pages 392, 433.

SECTION V

INSECTICIDES

SECTION V

INSECTICIDES

CHAPTER 25

Introduction

Insecticides may be divided into five main classes:

1. STOMACH POISONS,
2. CONTACT POISONS,
3. CORROSIVE POISONS,
4. FUMIGANTS,
5. PREVENTIVES.

1. **Stomach poisons** are employed against EATING INSECTS (i.e. those which have jaws to chew their food) principally CATERPILLARS and BEETLES. The poison is then taken with the food and acts through absorption in the stomach and intestinal tract of the insect.

Only those insects which feed upon the surface of plants can be attacked in this manner. Caterpillars, beetles and sawfly larvæ which live inside the tissues of plants, as the caterpillars of the codling, blister moth, pith moth, goat, clearwing, wood leopard, etc. cannot be reached by this means.

Since most of the stomach poisons available are also poisonous to man, care must be exercised throughout their preparation and employment. Thus, trees having fruit in a mature state cannot be sprayed without danger of poisoning the latter, and the grass in orchards where such poisons are sprayed will be rendered poisonous to stock for some period after the spraying of the trees.

The chief stomach poison employed is:

Arsenate of Lead.

In the past the following have been used to a considerable extent but are now almost given up, on account of their liability to cause damage to the foliage:

PARIS GREEN,
LONDON PURPLE.

Although trials with it have not been favourable in all cases, damage to the leaf having been reported, the following compound is being increasingly employed on account of its cheapness:

Arsenate of Calcium.

All these are compounds of *arsenic*. Two other substances which have been used satisfactorily in particular cases are

Powdered Hellebore,
Powdered Pyrethrum.

Another chemical which has met with some success is

Chromate of Lead.

All these substances may be used either in the dry form as powders blown on to the plant, or, as usually and more efficiently employed, in suspension in water (hellebore is not used in this manner) and applied to the plant as a **misty spray**. The *character of the spray* is important, the idea being to just *coat* the surfaces of the leaves, etc. with the substance, but not to wet the leaf sufficiently for the fluid to run off to any extent.

None of these poisons are of any value for *sucking insects*[1].

2. Contact Poisons

These are employed against sucking insects, i.e. those insects which live upon the plant juices of fruit trees, and possess some form of sucking beak adapted for piercing the tissues of the plant. Such insects are the aphides (or "lice"), plant bugs, and sucking mites and spiders. The poison is taken into the body, probably chiefly through the breathing pores (spiracles) of the insects and also possibly by direct absorption through the tender skin.

The most valuable of this class of insecticides is

Nicotine (or Tobacco).

This substance is an extremely active insecticide and has the great advantage of being without action in weak solutions on plant leaves and tissues.

Another popular contact poison is

Quassia.

[1] With the exception of pyrethrum.

Quassia appears also to have a beneficial action upon the foliage of the plant, and is thought by some to prevent future attacks. It is however much less active than nicotine and tobacco.

In addition to nicotine and quassia, there are doubtless many other substances obtainable from plant or animal sources which would be satisfactory contact insecticides. One or two are already known and form the basis of proprietary remedies, while others remain to be discovered. As a contact insecticide however, nicotine in its pure form, if reasonably cheap, leaves little to be desired. Of recent years it has unfortunately been difficult to obtain adequate supplies in this country.

CARBOLIC ACID probably comes into this class; its use has however almost died out on account of its scorching tendencies.

PYRIDINE, a substance allied chemically to nicotine, has been shown to have some value, especially against the capsid bug, but it is very much inferior in this respect to nicotine.

Soft Soap.

This substance is, by itself, an efficient contact insecticide, acting by blocking up the pores of the insect and so suffocating it. It is however in a class to itself, owing to its *spreading action* when used with many other insecticides. It enables such insecticides to have a more certain action, by ensuring a thorough WETTING OF THE INSECT with the spray. This is discussed in detail on page 452.

Other substances having a similar wetting power (though to a less extent) are

SAPONIN,
Starch and Flour Pastes,
Glue, etc.

Only the first of these is used in practice.

Contact poisons require quite a different method of spraying from that used with the other class (stomach poisons). It is necessary here to *thoroughly wet the body of the insect*, and a high pressure of the pump is required together with the use of plenty of the liquid. This is further discussed on pages 632, 661.

3. Corrosive Poisons

These substances have a *corroding* or burning action on the skin or exterior surface of insects or their eggs. They are mainly used during the winter, in the dormant state of the tree, as they all tend to injure

the leaf unless in a sufficiently dilute state. Their efficiency on insect eggs, even in the strongest forms possible to use, is open to grave doubt, and unreliable statements have been made of their success in this direction. The reason for this has been the natural shrivelling up of unfertile eggs which always occurs to a large extent in the aphis and bug class of insects.

The commonest of the corrosive poisons are

CAUSTIC SODA (or potash),
LIME.

Lime has also a further use which is described below. The action of the following upon insects is a little uncertain. Besides behaving as corrosives, they may also to some extent work as contact poisons (see above).

LIME-SULPHUR,
LIVER OF SULPHUR,
PARAFFIN and other mineral oils.

Liver of sulphur has also a destructive action on *red spiders* and lime-sulphur on *scale insects*. These are also both used largely as *fungicides* (Section VIII).

Paraffin is occasionally used by itself on trees in the dormant state, but is usually *emulsified* with soft soap, or in other ways. It may act as a contact poison to some extent. The nature of emulsions and their action are discussed on page 417.

Corrosive poisons require to be sprayed in a similar manner to the previous class (contact poisons). Plenty of liquid is to be used and a high pressure maintained in the pump.

GAS LIME,
KAINIT,
Soot,
Ashes.

These are used as insecticides for insects under the ground and probably belong to the class of corrosive poisons, though relatively weak in their action.

SALT.

This substance appears to have a pronounced action on insect eggs, especially when used with lime and particularly in the case of

Psylla (Apple Sucker). Its action is uncertain, but it probably extracts water from the vital fluid in the interior of the eggs by what is known as *osmotic action.*

4. **Fumigants.**

This class of insecticides acts in the form of vapour or gas and kills by being absorbed through the breathing pores of the insect. Fumigants are used on plants which can readily be enclosed in confined spaces, on nursery stock, and against insects in the soil. For insects above ground the most efficient fumigant is

HYDROCYANIC ACID GAS.

This is prepared from a *cyanide* as described on page 423. It is extremely poisonous to human beings and great care must be exercised in its use. It is very active and insects are poisoned by a few seconds exposure to the pure gas.

NICOTINE or Tobacco.

This is employed as a fumigant in the form of vapour by burning the tobacco leaves or evaporating the nicotine in a confined space.

For insects in the ground the most commonly employed substances are

CARBON BISULPHIDE,
NAPHTHALENE.

The former is a liquid which readily vaporises. It is injected into the ground by means of a syringe and is chiefly used against root forms of aphis (woolly aphis, phylloxera of vine, etc.).

Naphthalene is a solid which also vaporises, and is used in the form of a powder dug into the ground. It forms the basis of some proprietary soil-insecticide compounds.

5. **Preventives.**

Under this class come those substances which stop the insects from reaching the leaves and branches of the trees, and which prevent egg-laying or egg-hatching. The one of the greatest utility is the material known as

BANDING COMPOSITION (or "grease").

This is placed on bands around the trunks of trees to prevent insects from reaching the branches. It is chiefly useful against the

wingless female of the Winter Moth, which crawls up th trunks to lay its eggs in the branches. Compounds vary very much in their efficiency (see page 405).

Lime.

This, when sprayed in early spring on the trees, prevents the successful hatching of insect eggs by covering them over with an adherent coat. The new born insect is thus imprisoned and killed. Substances which have been used for a similar purpose include

Silicate of Soda,
Glue (gelatine).

CHAPTER 26

Insecticide Materials (arranged in alphabetical order)

ARSENATE OF CALCIUM

See also Arsenate of Lead, etc.

1. General

Employment

For destroying caterpillars etc. (as for arsenate of lead, page 397).

Description

Calcium arsenate (or "arsenate of lime") is a white powder, similar in appearance to arsenate of lead, but not so heavy. It is not at present manufactured in this country in any quantity, but may be made by the grower himself as described later.

There are very varying opinions as to its liability to scorch the trees, and many authorities condemn its use on this account. In insecticidal value it is about equal to arsenate of lead.

Preparation

It is necessary to have lime present in excess of the amount required to form the arsenate, otherwise scorching is *bound to occur*. The following method has been found to give satisfactory results in America:

FOR THE PREPARATION OF 100 GALLONS OF SPRAY SOLUTION.

1. Take **2½ lbs. of good quality[1] quicklime** ("*Buxton*" is the best to use in this country if obtainable) and slake it in a bucket by gradual additions of water. Mix into a thin cream with further water.

2. Dissolve **2 lbs. of commercial, "fused," arsenate of soda**[2] (or 3½ lbs. of crystallised arsenate) in **50 gallons of water** in a large tub of not less than 100 gallons capacity.

[1] The lime must not be "air-slaked" and should be in lump form and white or greyish-white in colour (see page 428).

[2] This is a violent poison and must be handled with very great care. For first aid treatment in case of poisoning see Appendix VII, page 705.

3. Pour the "milk of lime" (obtained as in 1) slowly, with constant stirring, into the arsenate solution. Then add water to make **100 gallons** of spray.

This is now ready for use.

If more than this proportion of lime is used, there may be scorching of the leaves due, not to the arsenate, but to the caustic soda produced by the reaction of the lime on the arsenate.

The ideal way would be to make say three trials, varying the amount of lime slightly each time, and find with the particular materials available which gives the least harmful mixture.

2. Method of Use

Strength of Spray

As above.

When and how to Spray

As for arsenate of lead (page 402).

Quantity of Spray Used

As for arsenate of lead (page 402).

Remarks

As scorching has been found with arsenate of calcium, it is advisable to make a trial first before using on a large scale.

3. Scientific

Chemical Composition

Apparently the tri-basic salt is produced, $Ca_3(AsO_4)_2 = 57 \cdot 8$ per cent. As_2O_5, on precipitation of arsenate of soda solution with milk of lime.

Properties

Arsenate of calcium is soluble in water about 1 in 200, so is much too soluble for spray purposes.

If excess of lime is employed (about half as much again) the arsenate remains almost insoluble.

Tests for Purity

Would be similar to those for arsenate of lead (page 403). The commercial product is hardly available at present.

Insecticidal Value

About equal to arsenate of lead.

ARSENATE OF LEAD

See also Arsenate of Calcium, Paris Green, London Purple, Chromate of Lead

1. General

Employment

For the destruction of caterpillars, beetles, sawfly larvæ and *all leaf-eating insects.*

Description

Arsenate of lead is a heavy white powder. It dissolves in water to only a very slight extent. It is obtained by adding a solution of a lead salt (such as the acetate or nitrate of lead) to a solution of a soluble arsenate (such as arsenate of soda) or arsenic acid. Although not so poisonous as "white arsenic" or as a soluble arsenate, it is, nevertheless, a powerful poison if taken into the stomach, and must be handled with great care[1]. It is a stable substance, i.e. not liable to change on keeping or exposure to air, and consequently its value as a spraying material does not alter on storing with the exception that, in the form of a *paste*, it is liable to dry and become hard by evaporation of the water (see below).

For spraying purposes it can be made by the grower by adding a solution of acetate of lead ("sugar of lead") to a solution of arsenate of soda. The quantities of each need to be very carefully adjusted or scorching of the leaves will result. Particularly is it necessary to avoid excess of arsenate of soda. For this reason, it is much better for the grower to use the *factory prepared arsenate of lead*, the forms in which this is obtainable being detailed below.

Arsenate of lead is a heavy substance and when used, suspended in water, for spraying tends to settle rapidly. The coarser the particles of arsenate are, the more quickly this settlement takes place. It is therefore very important to obtain it in as *fine a form as possible*, and manufacturers vie with one another in producing it in the finest obtainable condition. Simple tests for the grower to try with his own purchases are described below.

Preparation

On the large scale, arsenate of lead is prepared by adding a soluble salt of lead to a soluble arsenate in the correct proportions. The

[1] For first aid treatment in case of poisoning see Appendix VII, page 705.

white insoluble arsenate of lead settles out, and is obtained by filtration, and either dried to a powder or left in the form of a paste. If the grower wishes to prepare his own wash (which is not advised except in special cases) he should proceed as follows:

To make 100 gallons of spraying fluid.

Dissolve **10 ozs. of "crude" or "dry" arsenate of soda**[1] or **17½ ozs. of "crystallised" arsenate of soda** in **50 gallons of water** in a tub. This may be best done by tying the solid in a piece of sacking and suspending it in the water just under the surface. It may then be left till completely dissolved. Meanwhile, dissolve in a similar manner **35 ozs. (2 lb. 3 ozs.) acetate of lead** in a further 50 gallons of water in another vessel. When both are dissolved, stir the lead solution gradually into the arsenate solution. A white milky liquid is produced. This should now be tested in the following way:

Allow a little of the milky fluid to settle in a pail or can, and to the clear liquid add a little solution of arsenate of soda. An immediate cloudiness should be produced, showing the presence of an excess of lead acetate. If no cloudiness occurs, more lead acetate solution must be added to the main bulk until, when settled, it gives this test.

A more satisfactory, although a more troublesome, way to prepare the wash is to add the acetate of lead solution to the arsenate of soda solution, until about ¾ of the total is used, and then to settle each time before adding more, noticing if cloudiness is produced on further additions of the acetate. When no further cloudiness is seen, the wash is ready for use.

Commercial Brands

Arsenate of lead is sold in three forms:

1. Powder,
2. Paste,
3. Cream.

[1] Arsenate of soda occurs on the market in two forms, the "crystallised" and the "dry" or "crude." The latter is much stronger and is generally cheaper to buy. It however varies a good deal in strength and hence the need for testing when a grower makes up his own wash. Although a large excess of lead acetate will also harm (and is very uneconomical), the *important thing to avoid is an excess of arsenate of soda*: as this will scorch severely. The acetate of lead, as purchased, is not liable to vary in strength.

The **powder** is suitable for dry spraying, although it is not a common practice in this country (see page 706). It is however the worst form to use for a wet spray. This is because on drying the white precipitate, it loses much of its fineness, and on remixing with water will be found relatively coarse and quick-settling.

The **paste** form is the one in largest use at the present time. Pastes vary very much in the fineness of the particles and also in their chemical properties. There should be practically no free arsenate of soda present, and on mixing with the right quantity of water it should take a good time to settle (see tests below). The paste should not be too dry owing to evaporation of water, or it will be difficult to mix in the water, and will be relatively coarse.

The **cream** form is the most suitable of all. It mixes immediately on pouring into water, and its particles are generally in the finest possible state of division. Further, it may be *measured* out in making the wash, an improvement on the somewhat inconvenient weighing of the paste form.

A very important point in buying arsenate of lead in any form is to know the *strength in terms of arsenic oxide*. As the poisonous properties of the substance are due to the arsenic present and not to the lead, its efficiency, from a chemical point of view, depends on this figure. Most reputable firms will supply or even guarantee the strength in terms of arsenic oxide, "As_2O_5," of their product. While, however, the value of a given arsenate of lead as an insecticide is dependent upon its strength in terms of arsenic—more of the weaker products being required to be used per 100 gallons of wash made up—growers should give preference to those makes which have the finest particles and which therefore remain in suspension in the wash for the longest time. Not only do these prevent uneven spraying by not settling rapidly in the tank of the machine, but they are more efficient when sprayed on the leaf.

Simple Tests

1. TO ENSURE FREEDOM FROM SCORCHING.

(*a*) Procure some *acetate of lead* from the chemist. Dissolve about a teaspoonful of this in water in an 8 oz. medicine bottle, using distilled, well boiled, or rain water for the purpose. (The acetate is best dissolved in 4 ozs. of water and the bottle then filled up and shaken.)

(*b*) Take about a teaspoonful of the sample of arsenate of lead, and shake it up with about 4 ozs. of rain water (or distilled). Allow to settle.

(*c*) Pour off the clear settled liquor from the top of the arsenate of lead into a clean medicine bottle, and add a little of the clear acetate of lead solution. *Only the slightest trace of cloudiness should be seen.* If a distinct milkiness appears the sample contains free arsenate in solution and there is a danger of scorching foliage. This may be remedied by the addition of sufficient acetate of lead to the made-up wash, but it is safer to refer the matter to the manufacturer.

2. To test the fineness of the particles.

This is only a rough-and-ready test, but it will give useful information.

Place a new sixpenny piece on one pan of a small pair of scales[1] and balance on the other pan the correct quantity of the sample of arsenate of lead. Shake this well up with a small quantity of water in a 16 oz. medicine bottle. When it has completely mixed with the water, fill the bottle ¾ full and shake well. Allow to stand. The liquid will now be up to the 12 oz. mark. The white powder will commence to settle at once, but the rates of settlement with various brands are very different.

Make a note of how long it takes before there is a layer of clear liquid down to the 6 oz. mark (that is, the length of time that it takes for the powder to settle half way down).

In the case of the best samples, this will not occur for many hours. In many of the coarser arsenates, it happens in as many seconds.

As stated above, this is only a rough test of fineness. For instance, although a sample may contain a great many coarse particles which settle rapidly, these will not be shown if there are also enough finer particles of arsenate to give the test. It is however an excellent sorting-out test for a grower to use.

[1] If no small scales are handy it will be well to make up a larger quantity. For this purpose, take a pound of the sample, and mix it up well with half a pailful of water in a tub. Then add a further 3½ pails of water. Stir well and at once fill a medicine bottle of this for trial.

3. To find the percentage of arsenic present.

This gives the actual strength of the sample from the insecticidal (or "killing") point of view. It is not possible for the grower to ascertain this. He should get an undertaking[1] from the manufacturer or send a sample to an analyst, asking for percentage of arsenic present *as arsenic oxide* (As_2O_5). At the present time samples vary from about 12 to 20 per cent. As_2O_5 as pastes, and about 25 to 33 per cent. reckoned on the dried paste, or as powders. About 33 per cent. is, at present, the highest possible percentage of arsenic as arsenic oxide which can exist in a genuine arsenate of lead in the dry form.

Action on Insects

Arsenate of lead is for use with biting or chewing insects only. It is of no use for aphis ("green fly"), etc.

Caterpillars are killed in periods varying from 1 to 12 days, according to the dose of arsenic taken before they go "off feed." Thus a caterpillar may devour a whole leaf before feeling sufficiently ill to stop feeding. In most cases however caterpillars go "off feed" in a short time on leaves sprayed with arsenate of lead, and although they do not die at once, there is no further damage done.

2. Method of Use

Strength of Spray

This varies with the strength (in terms of arsenic) of the material and the manufacturer's directions should be consulted. Assuming an average strength of 15 per cent. of arsenic as arsenic oxide in the pastes, an efficient strength is **3 to 5 lbs. per 100 gallons of water.**

The strength of the spray however is obviously very dependent on the character of the jet used in the machine, and the amount put on the tree. Thus some growers prefer to use up to 7—10 lbs. of paste per 100 gallons of water, and to use only about a half the usual quantity of wash on each tree, employing a very fine spray jet. The same amount of arsenate of lead actually reaches the leaves in each case (see *How to Spray* below). The strength of home-made sprays is given on page 398.

[1] Legislation will probably soon be introduced to compel the manufacturer to state the strength of arsenic present (as arsenic oxide) in his product.

Preparation of Spray

Directions for preparing one's own spray from the original materials are given on page 398.

In the case of arsenate paste or powder, the correct amount of material is weighed and well mixed, first with a small quantity of the water in a pail. No lumps should remain. This is then poured off into the main bulk of the water and stirred well.

The liquid must be well stirred every time any is taken out for spraying, unless the machine is capable of taking the whole amount at one time.

When to Spray

A great deal is saved by spraying *as soon as possible after the pest is first noticed.* Much less spray is used when the leafage is younger, and the small caterpillars are more quickly killed. Further, they are destroyed before the chief damage, i.e. to the young foliage and buds, is done.

Directions as to the time of the year to spray will be found at the end of each description in Section IV.

How to Spray

A fine nozzle giving a MISTY SPRAY should be used, see figs. 252, 253, page 635. The idea is to envelop the tree in a fine "fog." If too much spray is used, or if the "mist" is too coarse, the liquid will drip off the leaves carrying the arsenate of lead with it, causing both loss of material and inefficiency.

Quantity of Spray Used

It is only possible to give approximate figures, as the amount necessarily varies so much with the state of the foliage.

The following table has been found useful:

Spread of trees, feet	Amount of diluted spray per 100 trees	Weight of arsenate of lead paste per 100 trees (using 4 lbs. per 100 gallons)
7	200 gallons	8 lbs.
10	270 ,,	11 ,,
15	460 ,,	18½ ,,
20	720 ,,	29 ,,
25	1120 ,,	45 ,,
30	1500 ,,	60 ,,
35	2200 ,,	88 ,,
40	2500 ,,	100 ,,

To ascertain the amount which will be required per acre, the above figures should be multiplied by the following factors, according to the distance apart of the trees:

6 ft, 12·1; 10 ft, 4·35; 12 ft, 3·02; 15 ft, 1·93; 18 ft, 1·34; 20 ft, 1·08; 24 ft, 0·75; 30 ft, 0·48; 40 ft, 0·28.

3. Scientific

Chemical Composition

There are at least two arsenates of lead in commercial pastes, and most pastes are mixtures of these two in varying proportions. These arsenates have the following composition:

$Pb_3(AsO_4)_2$ containing 25·5 per cent. of As_2O_5 (tri-plumbic arsenate).
$Pb_2H_2(AsO_4)_2$,, 33·1 ,, ,, (di-plumbic ,,).

Pastes contain varying proportions of water, but usually about ½ of the weight of a commercial paste is water (50 per cent.).

Arsenate of lead is manufactured by precipitating a solution of arsenate of soda (Na_2HAsO_4) or arsenic acid (H_3AsO_4) with lead acetate

$$[Pb(C_2H_3O_2)_2 3H_2O]$$

or lead nitrate $[Pb(NO_3)_2]$ according to the following equation (for the acetate):

$$\underset{372=1}{\overset{\text{arsenate of soda}}{2Na_2HAsO_4}} + \underset{1137=3{\cdot}06}{\overset{\text{acetate of lead}}{3Pb(C_2H_3O_2)_2}}$$

$$= \underset{899=2{\cdot}42}{\overset{\text{arsenate of lead}}{Pb_3(AsO_4)_2}} + \overset{\text{acetic acid}}{2HC_2H_3O_2} + \overset{\text{acetate of soda}}{4NaC_2H_3O_2} + \overset{\text{water}}{9H_2O}.$$

The di-plumbic arsenate is also produced in varying proportions.

Tests for Purity

1. Water per cent. (by drying at 100° C.).
2. Arsenic as As_2O_5.
3. Insoluble powders other than arsenate of lead: by examination of insoluble residue after treatment with nitric acid: Ca, Ba, Zn, etc. by usual chemical methods.
4. Soluble arsenate and arsenic acid. In filtered liquor as above by usual methods.

Insecticidal Value

The toxic dose for full grown caterpillars varies a good deal.

Careful investigations by the author have shown that on an average an

amount of the paste (50 per cent.) equal to $\frac{1}{20}$ per cent. of the body weight of a caterpillar will stop it feeding in an hour or two and kill it in a few days.

Even if poisoned caterpillars appear to recover, they usually fail to pupate successfully.

Remarks

Approximately 1 ton of arsenate of lead paste (50 per cent. water) is produced from $12\frac{1}{2}$ cwt. of acetate, equivalent to $7\frac{1}{2}$ cwt. of litharge (PbO).

BANDING COMPOSITION

1. General

Employment

Used for smearing round the trunks of fruit trees to catch insects crawling up to the branches.

Description

The practice of "banding" fruit trees is by no means a novel one. It dates from the time of the general recognition of the damage done by the female of the WINTER MOTH (see page 176). This insect is practically wingless, and is obliged to crawl up the trunks of trees in order to lay her eggs on the branches. The caterpillars of the moth are by far the most destructive to fruit of any in this country, and as each moth is capable of laying some hundreds of eggs, the attack can be very greatly reduced by this means.

More than one experienced grower is of the opinion that the attack cannot be *absolutely eradicated* by banding the trees, even when the most elaborate precautions are used to prevent the insect passing the band (as for instance, applying the composition both on the surface of the band, and underneath it also, and using two bands, one over the other, so as to catch any on the second one which may successfully pass the first). The only explanation of this appears to be that in some rare cases the male may carry the female to the branches while in the act of pairing[1].

[1] The author understands that this has been proved to occur in some plantations abroad.

In spite of this there is no question whatever of the immense benefit resulting from careful and systematic banding. If any grower doubts this, it is a good plan to leave a few trees unbanded in an orchard and then notice the difference the following summer between these and the banded ones.

Even if the results were less successful than they usually are, it would still be an excellent practice, since it gives the grower time to get his arsenate of lead, or other poison spray, applied before the damage to the young leaves and buds is too great.

Properties

Previous to about the year 1910, the only materials available for banding were various kinds of GREASES. These were mainly of the cart-grease or wagon-grease order, and prepared by mixing various proportions of mineral and vegetable oils and fats with or without rosin and treating the mixture with milk of lime or magnesia, etc. The disadvantage of these greases was that, sooner or later, they dried up, even when applied in a thick coat to the trunk. This necessitated renewal once or twice during the winter in order to remain efficient in their action. Further, the grease was injurious to the bark of the tree, and it had to be applied upon grease-proof paper, which was tied with string around the trunk. About ten years ago a new kind of composition for the purpose appeared from America. This was very much stickier and more adhesive than greases (and proportionately more efficient) and it remained sticky throughout the whole season, showing no tendency at all to "skin over" or "dry up."

Although this composition (called "Tanglefoot") may be placed directly upon the bark of trees without injuring them, the use of a band of paper is generally preferred, as it is better to keep the trunk of the tree clean, and the bands can be completely removed each year.

Several similar compounds of German origin, termed "moth glues," also appeared about the same time, but have no sale in this country. Since the introduction of "Tanglefoot" other similar brands have appeared, competing in price and quality with the original article. In all of these, the use of a large band, such as was advisable in the case of the old greases, is no longer necessary. This compensates for the increased cost of the material which is considerably over double the price of the greases formerly used.

Requirements and Tests

The only tests of any value are practical ones, based upon its behaviour under the actual climatic conditions when in use. These may be summarised as follows:

1. The composition obtained should be, and should remain, sufficiently adhesive to catch both the smallest and largest insects.
2. It should show no tendency to run down the trunk of the tree, even if liberally applied and exposed to the hot sun.
3. It should remain quite sticky throughout the winter and spring and not require renewal.

The only exception to this is in the case of windy and dusty weather, when a film of dust may form over the surface of the band. In such cases, it is only necessary to pass the hand or a stick over the band, and so expose a fresh surface of the material.

4. It should not harden under frost.
5. It should not be so stiff as to render application to the band difficult.

2. Method of Use

Preparation

It is not advised for the grower to attempt to prepare his own banding composition, as this is best done by the use of special plant under factory conditions and control.

Procedure

For large plantations the following methods will be found very expeditious.

1. The paper, which should be of good, strong, grease-proof variety, is supplied in rolls and sheets. Rolls are best for small and mixed plantations. If trees are of uniform age and size, the sheets may be used and cut to strips of the required size. A width of about 5 inches is generally sufficient, and the paper should overlap about an inch when tied round the trunk.
2. One or more labourers (women are largely employed on this work) carry the paper in strips or rolls and paste it on the trees with ordinary flour paste[1]. They are followed by more who tie the string round. Two lengths of string are used one at the top and one at the bottom margin of the band, and it is

[1] If the bark of the tree is very rough and uneven it should be scraped to a smoother surface before applying the paste.

Fig. 213. Photograph of part of band on an apple tree showing the males and females of the Winter Moth caught by the composition. Natural size.

tied as tightly as possible to avoid spaces between the paper and the bark of the tree. (If the insects can crawl under, it is obviously useless to safeguard the surface.)

3. One or two workmen now follow with pails or boxes of the composition, and wooden sticks with broad ends or other suitable implements for placing the composition on the bands. This is an operation requiring some skill and experience. An even coat, not too thick, should be used, otherwise there is considerable wastage of material.

Important. If there is a tree stake, this *must also be banded.*

The half-closed palm of the hand is sometimes used to apply the composition, the workmen or women walking backwards round the tree, and keeping the hand in contact with the band.

When to Band

Banding should take place *as early in the autumn as possible.* If left too late, there is a chance of the Winter Moth appearing early and the damage is then done. It is well to apply sufficiently early to ensure that every tree is banded BEFORE THE END OF SEPTEMBER.

It is useful, though not necessary, to keep bands sticky and in efficient operation until spring spraying commences, say till the beginning of May. Not only are other moths caught, such as the March, Mottled Umber, etc., but numbers of Apple-Blossom Weevil, which frequently crawl up the trunks, may be prevented from reaching the buds. In any case, the bands should be kept operative *till the end of March* to catch the *March Moth.* A periodic inspection of the bands from October onwards should be made.

It is well to remove the old bands in the early summer, and destroy them, so that there is no chance of the eggs, of which there are usually quite a number, hatching. It is always worth while to examine the bands closely and many growers keep a record of the number and variety of pests caught.

Quantity of material required

The following figures are based upon much experience and can be relied upon as a close guide. They allow for a fairly liberal application of the banding composition.

A. Paper. *Assuming a width of 5 inches and allowing an overlap of one inch.*

Diameter of trees (inches)	Length of paper for 100 trees (feet)	Average weight (ozs.)	Length of paper *per acre* for distances of trees apart as under (feet)				
			6	10	15	20	25
1	34½	2½	397	137	62	35	21
2	60	4¼	690	240	108	60	36
3	87	6¼	1050	348	157	87	52
4	113	8	1300	452	203	113	68
5	140	10	1610	560	252	140	84
6	165	11¾	1900	660	297	165	99
7	191	13½	—	764	344	191	115
8	218	15½	—	872	392	218	131
9	244	17½	—	976	440	244	146
10	270	19¼	—	—	486	270	162

The string required is roughly double these lengths.

B. Composition. *For paper of 5 inches width, bigger bands in proportion.*

Diameter of trees (inches)	Weight of "grease" for 100 trees (lbs.)	Weight of "grease" (in lbs.) *per acre* for distances of trees apart as under (in feet)				
		6	10	15	20	25
1	1½	17¼	6	2¾	1½	1
2	3	34½	12	5½	3	2
3	4½	53	18	8	4½	3
4	6½	75	26	11¾	6½	4
5	7¾	89	31	14	7¾	4¾
6	9	103	36	16¼	9	5½
7	10	115	40	18	10	6
8	13	150	52	23½	13	7¾
9	14½	166	58	26	14½	8¾
10	15½	178	62	28	15½	9¼

CARBOLIC ACID

Employment

Carbolic acid or "Phenol" has, in the past, been largely used both as an insecticide and fungicide. It is however relatively weak and is liable to cause injury to the leaves. For this reason it has been superseded by more powerful and suitable substances.

Description

Carbolic acid is obtained from coal tar. When pure it is a solid substance, crystallising in long needles. It however liquefies with the slightest trace of water. It is soluble in water to the extent of 5 per cent. and has powerful burning properties. It is also known as one of the best antiseptics (disease-germ destroyers).

Application

It cannot be used at a higher strength than **10lbs.** to **100 gallons** of water, as injury to the plant then occurs. At this concentration it is a weak insecticide for aphis, psylla (sucker) and plant bugs. Solutions containing 5 lbs. of soft soap and 5 lbs. of carbolic acid per 100 gallons have been employed for spraying against apple-blossom weevil, and are recommended by *Whitehead* for this purpose.

Carbolic acid has also been advised by *Lees* for destroying those buds of currants which are infested by the big bud mite (see page 371).

CARBONATE OF SODA

Employed for softening water. **See page 461.**

CARBON BISULPHIDE

1. General

Employment

Used as a soil insecticide and fumigant for destroying underground pests.

Description

Carbon bisulphide, or bisulphide of carbon (more correctly *disulphide*) is a colourless liquid, heavier than water. The commercial article has an unpleasant smell, recalling rotten cabbage. It will not mix with water.

IT IS EXTREMELY INFLAMMABLE and must be handled with great care on this account.

It readily vaporises, and its vapour is very poisonous to all insect life, also to human beings if inhaled in any great quantity.

It is used in the form of injections into the ground, principally to kill the root form of woolly aphis (see page 332).

Simple Tests

The commercial substance may be adulterated with paraffin oil. This may be detected by means of a *hydrometer* (see page 615).

Fill a tall glass cylinder with the liquid, and place the hydrometer in so that it floats (if it sinks to the bottom, a lighter one must be used, and if it floats too high, a heavier one).

Now read the mark on the scale at the level of the liquid. This should not be below 1·26. (On Twaddell's hydrometer $= 52°$ or Beaumé $= 30°$.)

Another simple test is to place a little of the liquid in a watch-glass or other glass dish, and allow it slowly to evaporate in a room. (*Keep away from flames.*) After a few hours the liquid should have evaporated off, leaving the surface of the glass clear and dry.

If these tests seem to show adulteration, the sample should be sent to an analyst for examination.

Commercial Data

Usually sold in iron drums or taper cans with screw top. Smaller quantities are retailed by the druggists.

2. Method of Use

Procedure

It is best to use a special form of syringe or *injector*. The carbon bisulphide is placed in this, and the nozzle of the injector is then forced into the soil to a depth of about 6—8 inches. Four or more injections are made at a distance of about 2 to 2½ feet from the trunk, and at equal distances apart. Care should be taken that

the roots themselves are not wet with the liquid, and if a root is struck with the injector, a slightly different position should be selected. The vapour is quite harmless to the roots.

Amount to use

From about 1½ to 5 ozs. according to the size of the tree.

When to apply

For woolly aphis attack, it is best to apply it in the late winter, but in any case before April. March is a very suitable month.

A day should be selected at the end of a spell of dry weather, as it is much more effective in dry soil.

Remarks

Besides killing the root form of the woolly aphis, the vapour will destroy weevils, chafers, sawfly maggots, caterpillars, pear midge, etc. It does not appear to kill the pupæ.

3. Scientific

Chemical Composition

It consists of one atom of carbon, combined with two atoms of sulphur (CS_2).

Properties

Colourless, mobile, highly refractive liquid, sweetish odour when pure.
Specific gravity 1·29232 at 0° C.
Boils at 46° C., solidifies at − 110° C.
Very inflammable.
Only very slightly soluble in water (0·17 per cent. at 15° C.).
Miscible with oils.
Prepared commercially by passing the vapour of sulphur over red-hot charcoal.

CARBON TETRACHLORIDE

Employment

Used as a soil insecticide, or fumigant for stored produce.

Description

It is a very heavy liquid, not soluble in water. Has a sweet odour resembling chloroform.

It is used in some cases to replace carbon bisulphide but is much less effective. It has, however, the advantage of being non-inflammable and it is used where there may be danger of fire.

Method of Use

As a fumigant, about 2—3 lbs. for every 100 cubic feet is required. For treatment of soil, it should be used in the same manner as for carbon bisulphide, but 2—3 times the amount is required. Its employment is not advised except in special cases.

Chemical Composition

It consists of a combination of one atom of carbon with four of chlorine (CCl_4) and is closely allied to chloroform ($CHCl_3$).

CAUSTIC SODA

See also Lime, Lime-sulphur

1. General

Employment

As a strong winter wash for fruit trees, both alone and in the form of emulsion with paraffin oil.

Description

Caustic soda must be distinguished from carbonate of soda or "soda" which is practically useless as a cleansing agent.

Caustic soda should be kept in *tight packages*, away from the air, as it soon loses its caustic properties, and is converted into carbonate of soda by the action of the "carbonic acid" in the atmosphere.

Although very effective alone, especially at the higher strength of 2½ per cent., the eggs of insects are more certainly destroyed by

using an emulsion of paraffin with caustic soda added (for directions see page 420). It may also be used with sulphate of copper (see page 611).

Properties and Simple Tests

Caustic soda has a *very powerful burning action* on the skin, and must be carefully handled. During spraying operations the faces and particularly the eyes of the men should be protected by masks and they should wear old clothes, as these will be spoilt by the spray.

India-rubber gloves are the best to protect the hands and it is always as well to have a pailful of water with about a pint of vinegar stirred into it for the men to bathe any part affected.

The spray solution should be used as soon as possible, or kept away from the air, as it loses its efficiency if left exposed.

Commercial Brands

Caustic soda may be obtained in powder form in sealed tins. This is very high strength, usually 98 per cent. purity, and it is the best form in which to obtain it.

It can also be bought in lumps, but these usually contain more moisture and impurities.

A guarantee of strength should always be insisted upon, and if weaker than say 95 per cent. proportionately more must be used in the spray.

Action on Plants

Caustic soda must only be used on trees *during the dormant season.* It has a powerful burning action on the foliage, and it destroys all forms of low vegetable growths, such as moss and lichen on the bark.

Action on Insects

Caustic soda, at the strength employed for winter washing, will kill most insects, and it destroys a good percentage of eggs when these are properly wet by the liquid. The chief benefit to be derived from the spray is the destruction and removal of dead bark, moss, lichen, etc., in which harbour many insects, eggs, and fungus spores. For the treatment of the latter, however, *lime-sulphur* is preferable (see page 612).

2. Method of Use

Strength of Spray

Per 100 gallons of wash.

Use **20** to **25 lbs**. of pure (98 per cent.) fresh caustic soda.

Preparation of Spray

Place the caustic soda in an iron or wood vessel (iron is not affected by it, but with galvanised vessels the zinc lining is rapidly attacked) and add about 5 gallons of water.

Stir occasionally till dissolved (heat is generally developed). Then add the bulk of the water and stir well.

When to Spray

During the winter months only. It is advisable to choose a spell of dry weather, as a shower falling after the application of the spray will wash the material off the trees.

How to Spray

Use plenty of liquid and a powerful, somewhat coarse spray. The object is to force the liquid between the crevices of the rough bark and under the moss and lichenous growths.

Quantity of Spray Used

The following figures represent an average of quantities used in practical work.

Spread of trees	Quantity of liquid per 100 trees	Weight of caustic soda (98 per cent. purity) per 100 trees
ft.	galls.	lbs.
7	160	3½
10	220	4½
15	380	7½
20	600	13
25	920	20
30	1300	30
35	1850	42
40	2400	55

To obtain the quantity required per acre, multiply the figure for 100 trees by the following factors, according to the distance apart in feet: 6 feet 12·1, 10 feet 4·3, 12 feet 3, 15 feet 2, 18 feet 1·3, 20 feet 1, 24 feet 0·75, 30 feet 0·48, 40 feet 0·28.

3. Scientific

Chemical Composition

$NaOH = 40$.

Properties.

Powerfully caustic and alkaline.

Combines with acids to form salts of sodium. (Thus it combines with hydrochloric acid or "spirits of salts" to form sodium chloride or "common salt.")

Rapidly absorbs CO_2 from air, becoming "carbonated."

Deliquescent (absorbs moisture from the air).

CHROMATE OF LEAD

See also Arsenate of Lead, etc.

Employment

As a caterpillar poison.

Description

Chromate of lead is produced by adding a solution of acetate of lead to bichromate of soda. The chromate of lead is thrown down as a fine yellow precipitate known as "chrome yellow."

Although not so poisonous as arsenate of lead, it has been reputed to adhere to the leaves for a longer time, and so to remain effective for a greater period.

Strength of Spray

If the dry chromate is used, a suitable quantity is from **3 to 5 lbs. per 100 gallons of water.** If the chromate is prepared, the quantities to be used are as under.

Preparation of Spray

Take 4 lbs. of crystallised lead acetate, and dissolve in 50 gallons of water in a large vat holding 100 gallons. Take a large pailful of this solution and place on one side. Dissolve separately about 2 lbs. of bichromate of soda crystals in 20 gallons of water. Add this to the lead acetate until further additions produce no further cloudiness to the settled liquor. Now add the pailful of lead acetate solution, fill up to the 100 gallon mark and stir well. This gives 100 gallons of spraying solution.

COAL TAR

Employment

Coal tar is not used as an insecticide. It is useful however to paint over the exposed wounds of trees both after pruning and especially after cutting out canker growths, etc.

Stockholm tar is preferred by some growers for this purpose, but coal tar is cheaper and appears to answer equally as well. Lead paint or carpenters' knotting also fulfils the same purpose, but tar is preferable in cases of fungus disease, as it prevents successful germination of the spores.

Description

Coal tar is too well known to need description. It is a very complex mixture of substances and is obtained in the distillation of coal in the production of coal gas. It is readily obtained from any gas works.

EMULSIONS (Paraffin)

1. General

Employment

1. With soap for obtaining better penetrating or "wetting" power.
2. With soap, as an insecticide, principally for aphis.
3. With other substances such as iron and copper solutions (Woburn emulsions) as insecticides.
4. With caustic soda as a winter wash for destroying eggs.

Description

Practically all oils, and many other liquids insoluble in water, possess the property of producing *emulsions* when shaken up with solutions of certain substances.

In these cases the oil is broken up into very minute globules each of which is surrounded by a film of the watery solution. A thick milky fluid is produced, and in some instances the emulsion becomes almost or quite solid.

A familiar instance of an emulsion is *milk* which consists of an emulsion of about 3 to 4 per cent. of butter fat in a solution of casein.

Emulsions may last only a short time or they may be practically permanent. Thus, if oil is shaken with water alone, the emulsion produced rapidly separates, the oil floating to the top of the water almost immediately.

Since paraffin oil has a very pronounced burning action on foliage it follows that only emulsions which are practically permanent are safe to use for spraying.

The most widely used and the most satisfactory emulsions are those in which paraffin oil is emulsified with solutions of soft soap. Much investigation has been carried out to find the best proportion to use of each so that an efficient wetting of the leaf and insect is obtained and consequent killing action, with at the same time safety to the plant.

Since the preparation of the emulsions for spraying must often be left to semiskilled and unskilled people there is always *some* risk in the use of paraffin as an insecticide. If however emulsions of the right strength are properly prepared and intelligently used there is no question of either their efficiency or safety.

In addition to the emulsions as ordinarily prepared, paraffin oil is also employed as a more or less "soluble paraffin soap." This is produced by boiling soft soap and paraffin oil together in various proportions. Under these conditions the oil dissolves in the soap. On dilution a certain amount of the oil is thrown out of solution but is in the form of an emulsion. Such "soluble paraffin" and "paraffin soap" is often used, but it has been shown not to be anything like so effective as the freshly prepared emulsion made by the grower himself.

2. Method of Use

Preparation

1. *Emulsion with soft soap.*

The soap is first boiled with a proportion of the water and the paraffin oil then added and thoroughly churned up by charging and discharging a pump fitted with a *rose nozzle*. Any other kind of agitation is unsuitable for the purpose. (A garden syringe is very efficient.) The remainder of the water is then added and the whole well stirred up.

2. *Emulsions with iron and copper solutions.*
The sulphates of iron or copper may be used to produce emulsions. To a solution of one of these is added the requisite quantity of lime and the paraffin oil is then churned up with it in the usual manner.
3. *With caustic soda.*
This is for winter washing. The emulsion with soft soap is made in the ordinary way and the soda then added.
Some separation may occur but this does not appear to affect the efficiency of the spray. The iron and copper solutions may also be used with caustic soda[1].

Action on Insects

The action of paraffin emulsion on insects is not fully known. It appears to have some corrosive action on the skin of caterpillars and also acts as a direct contact poison. Emulsions form an excellent vehicle for applying other insecticides such as liver of sulphur and nicotine.

Strength of Spray

A. Using soft soap.

1. *Summer Spray.*

Per 100 gallons of wash.

Soft soap 10 lbs.
Paraffin oil 1 gallon.

2. *Early Spring or Autumn Spray.*

In this case either the buds are not fully opened or the leaves are old and not very susceptible to the spray.

Per 100 gallons of wash.

Soft soap 20 lbs.
Paraffin oil 2 gallons.

These quantities are for water of medium hardness (e.g. 15 or thereabouts[2]). There should be in the first case at least 6 lbs. and in the second case 15 lbs. of **free soap** present. Consequently, if harder water than this is used, correspondingly more soap must be employed to give permanent and safe emulsion.

[1] See Pickering, *Woburn Reports.*
[2] See page 458 on hardness of water.

B. Using copper or iron sulphates.

Per 100 gallons of wash.

Copper sulphate 6 lbs.
Lime water 85 lbs.
Paraffin $1\frac{1}{2}$ gallons.

The copper sulphate is first dissolved in a little of the water and the settled clear lime water run into it. The paraffin is then added and the whole churned up with water to the 100 gallons. In the case of iron sulphate, the same quantity is used as of the copper but milk of lime may be employed in place of water. The quantity necessary is about 3 lbs. of quicklime, slaked and made up into a cream with water (for further particulars see Pickering, *Woburn Reports*).

C. Using caustic soda.

The caustic soda is dissolved in a little water and added to the emulsion prepared either with soap, copper, or iron sulphates.

Per 100 gallons of wash.

Emulsion as above, 100 gallons.
Caustic soda 20 to 30 lbs.[1]

How to Spray

As for Soft Soap, see p. 455.

Quantity of Spray Used

As for Soft Soap, see page 456.

GAS LIME

Employment

As a soil dressing for killing all forms of insect life. It is specially fatal to snails and slugs.

Description

Gas lime is the waste slack lime after it has been employed for the purification of coal gas, and it contains a great many substances besides lime. When fresh, it is very destructive to vegetation. If it is mixed with other soil, it soon changes by absorption of oxygen from the air. If used fresh, it should not be

[1] According to purity and strength required (see page 415).

placed too close to the tree or plant, and should be spread upon the surface of the ground till the air has had time to act upon it.

Chemical Composition

The following is an analysis of fresh gas lime:

Calcium hydrate	15·1 %
,, carbonate	24·2
,, thiosulphate	11·8
,, sulphide	6·9
,, oxysulphide	3·2
,, sulphate	0·2
,, sulphite	0·5
,, cyanide	0·2
Iron sulphide	0·6
Sulphur	4·3
Silica	1·8
Alumina	0·7
Tar	0·2
Water	30·3
	100·0

HELLEBORE

See also Pyrethrum

1. General

Use

Hellebore is poisonous to all leaf-eating insects and is employed to a considerable extent in dealing with SAWFLY (including slug worm) attack on small bush fruit, such as currants and gooseberries. It is practically never used on a large scale, or for caterpillar on fruit trees.

Description

Hellebore powder is obtained by grinding up the roots of the White Hellebore (*Veratrum album*) and the Green Hellebore (*Veratrum viride*). The former plant is common in some parts of Europe but not in Britain, and the latter occurs fairly commonly but is a native of America.

Both plants owe their action mainly to the poisonous principle termed *Veratrine*, which is employed medicinally.

Properties and Simple Tests

Hellebore powder should consist of the dried ground root. It should be finely powdered and contain no coarse particles. It is liable to adulteration with flour or starch and this can be detected by examination under a microscope.

Action on Insects

Hellebore is a poison to leaf-eating insects. The powdered root is only from one-half to one-third as poisonous to caterpillars as arsenate of lead.

2. Method of Use

Application

The powdered root is used alone or mixed with flour. It may then be blown on to the leaves of the plant by means of a sulphurator or, as usual in a smaller way, with a pair of bellows, or simply by placing in a muslin bag and "dusting" this over the plants by shaking the bag. If preferred, the powdered root may be stirred into water in the proportion of **2—4 lbs.** to **100 gallons** and this at once sprayed on the plants. Unless a very fine spray is used, however, much of the actual poison, being dissolved by the water, runs off the leaf, and the other method is preferable.

Time to Apply

It is best applied to the plants at dusk so that the dew may assist it in adhering to the leaves, and render it more active.

Remarks

In the case of gooseberries and currants, and small bush fruit, it is preferable to use Hellebore in place of arsenate of lead, since there is risk of poisoning the fruit with the latter. Even with Hellebore care must be taken, as this is also a poison, but it is much weaker than arsenate of lead and will probably be washed or blown off the fruit before this is picked.

3. Scientific

The alkaloid *Veratrine*, to which Hellebore owes its action, is obtained in white crystals, melting at 202° C. It is soluble in 1000 parts of water and in 3 of alcohol. It forms soluble salts with acids.

Tests

It dissolves in concentrated sulphuric acid giving a yellow coloration which *gradually changes to blood-red.*

HYDROCYANIC ACID GAS

1. General

Employment

For the fumigation of plants to kill all insect life. Chiefly for nursery stock and plants under glass.

Description

This gas is produced when cyanides are treated with mineral acids, such as sulphuric acid (oil of vitriol). When dissolved in water it is called *Prussic Acid*. Both the cyanide and the gas are EXTREMELY POISONOUS, and must be handled or produced with the greatest care.

Although chiefly used for nursery stock and plants under glass, it is often employed, especially abroad, for young trees in the open. In such cases, an impervious kind of canvas sheet or tent is erected or hoisted over the tree and the gas produced inside this cover. In greenhouses, fumigation with this gas is used for the destruction of mussel scale, aphides, mealy bug, thrips, red spider, and weevils. Fumigation of nursery stock kills all kinds of insect life in the young trees, and also a proportion of the eggs. It cannot however be relied upon to destroy all eggs, even when the action is prolonged and the gas used at high strength.

Materials employed

1. POTASSIUM CYANIDE.

   This is sold in two forms:
   a. Lump cyanide, of 98—100 per cent. purity.
   b. Stick cyanide, of about 40 per cent. purity.
   It is better to purchase the former quality and to get a guarantee of strength.
   It occurs as white hard lumps.

2. SODIUM CYANIDE.

   This is cheaper to buy and just as effective for fumigation.
   It is sold as "130 per cent. strength." This is because it liberates 30 per cent. more gas, weight for weight, than the potassium cyanide. It is about 98—99 per cent. actual purity.

It dissolves more readily than the other salt and is, on this account, preferable when cheaper.

Both these cyanides are extremely poisonous and should be kept in tight packages, prominently labelled "POISON."

3. SULPHURIC ACID (oil of vitriol).

The "pure concentrated acid" is the best to purchase. It should test not under "1·83 specific gravity" though this is not a reliable test of strength, and the purity should consequently be guaranteed. Strong sulphuric acid has a violent burning action on the skin and should be used with great caution.

2. Method of Use

Quantities required

For every 100 cubic feet of space use:

1. FOR HARDY PLANTS.

$\frac{1}{2}$ oz. of sodium cyanide ("130 per cent.").

$\frac{2}{3}$ oz. of potassium cyanide (98—100 per cent.).

or

1 oz. of sodium cyanide for 200 cubic feet of space, and

1 oz. of potassium cyanide for 154 cubic feet of space.

2. FOR TENDER PLANTS.

0·154 oz. of sodium cyanide ("130 per cent.").

$\frac{1}{5}$ oz. of potassium cyanide (98—100 per cent.).

or

1 oz. of sodium cyanide for 650 cubic feet of space, and

1 oz. of potassium cyanide for 500 cubic feet of space.

For every 1 oz. of potassium cyanide used take 1 fluid ounce of sulphuric acid and $3\frac{3}{4}$ fluid ounces of water.

For every 1 oz. of sodium cyanide used, take $1\frac{1}{2}$ fluid ounces of sulphuric acid and 5 fluid ounces of water.

Procedure

The following precautions should be observed to the letter and the operation carried out by *a skilled person* to avoid risk of accidents.

1. See that every chink and crevice is closed up and the house made as air-tight as possible.
2. Place the correct amount of water in an earthenware jar and stir the strong acid, previously weighed, into it; allow to cool.

3. Weigh out the calculated quantity of cyanide and wrap it in a piece of gauze or close-mesh netting. Tie this round with a long piece of string and pass the end of the string through a hole in the wall or roof of the house, arranging so that it is suspended just over the jar of acid and can be lowered into it from the outside.
4. Close the door of the house and block up all the crevices at the sides, bottom and top.
5. From the outside, lower the packet of cyanide into the acid.
6. Allow an hour to elapse, then open the door wide *from outside*, but do not enter for *several hours*.

In cases of poisoning by the gas, a douche of cold water on the face, or the use of sal volatile is advised. Prompt action is essential.

When to Fumigate

The evening is the best time. There must be no direct sunlight. The temperature of the house should not be over 60° F. and the plants, as well as the surface of the ground, should be as dry as possible.

Since eggs are not killed by this strength of the gas, a second fumigation should be made after an interval of about two weeks.

Nursery Stock

An airtight box or tent may be used for this purpose.

A higher strength of gas should be employed. It is advised to use 1 oz. of sodium cyanide or 1⅓ ozs. of potassium cyanide for every 100 cubic feet of space[1]. There is a good chance of eggs being killed by this strength, though reliance must not be placed on it. The stock should be *dry*, and the box must be opened so that the fumes blow away from the operator.

3. Scientific

Chemical Composition

Hydrocyanic acid is the cyanide of hydrogen, HCN, *i.e.* carbon combined with one atom each of nitrogen and hydrogen. Liberated with effervescence from all cyanides on treatment with mineral acids. (The *ferrocyanides* are quite different chemically.)

[1] *Report on Economic Zoology.* Wye, 1908, p. 82.

Properties

Colourless gas, lighter than air, having an odour resembling almonds.
Extremely poisonous.
Readily soluble in water (the solution is known as prussic acid).

KAINIT

See also Naphthalene, Gas Lime, Bisulphide of Carbon

1. General

Employment

Kainit has been found of benefit as a top dressing for soil around fruit trees. It is said to kill or injure the pupæ of various insects, and also those larvæ which live in the soil, such as the cockchafer grub and swift caterpillar. For complete list of insects which spend the winter in the pupal state in the ground and of larvæ which live in the soil, see under "Naphthalene" (page 433).

As it is also an excellent fertiliser its use is recommended even if more powerful insecticides, such as Naphthalene, are also employed.

It is of proved value in cases of injury by slugs and snails.

Description

Kainit is a natural mineral deposit, and is a mixture of salts of potash and magnesia. It also contains variable amounts of common salt. The potash is the most valuable constituent from the manurial point of view, and the amount present varies from 12 to 20 per cent.

How to Buy

The percentage of potash should be guaranteed and the price charged should be in relation to the amount present. An average grade contains about **13 per cent. of potash** present (as K_2O).

2. Method of Use

When to Use

It is best to dress the ground

1. When the caterpillar is nearly mature.

   On falling to the ground to pupate it is then most easily killed.

2. When the pupal state is nearly over.

   This is early for the Winter Moth[1], December Moth, March Moth and Mottled Umber, but for the others the best month is probably early March.

3. For beetle grubs, when these are young, in early autumn.

How to Use

For mature caterpillars, spread the Kainit over the surface of the ground. In other cases work it into the surface soil.

Quantity Used

The amount employed, of course, varies with the size of the trees and their distance apart. For an average orchard of fair-sized trees, about 5—6 cwt. per acre is required, and this is placed around the trees to correspond with the spread of the branches.

3. Scientific

Chemical Composition

Pure Kainit corresponds to the formula:

$$K_2SO_4 + MgSO_4 + MgCl_2 + H_2O.$$

An average analysis of the commercial material gives:

K_2SO_4 21; KCl 2; $MgSO_4$ 14; $MgCl_2$ 12; NaCl 35; $CaSO_4$ 2; Insoluble 0·8; Water 13·2.

Total Potash as $K_2O = 12{\cdot}7$ per cent.

Tests for Adulteration

The value depends upon the potash present which may be determined by the Platinic chloride or Perchlorate methods.

[1] Banding is of course the best remedy for Winter Moth and the treatment of the ground may then be safely neglected (see page 404).

LIME

See also Gas Lime

1. General

Employment

1. As a spring "cover wash" to prevent the hatching of aphis, psylla (sucker) and other insect eggs.
2. In the preparation of "Lime-Sulphur" (see page 613).
3. In the preparation of "Bordeaux mixture" (see page 606).
4. In the preparation of "Arsenate of Calcium" (Calcium Arsenate) (see page 395).
5. As a water softener (page 461).

Description

Lime is prepared by burning limestone and chalk in a kiln. It varies a great deal in purity according to the quality of limestone used.

Lime when freshly burnt is "caustic" and unites vigorously with water, much heat being developed. If the lime is kept exposed to the air it rapidly crumbles and is called "air-slaked." Such lime is quite useless for insecticidal purposes.

The best quality of commercial lime is that prepared in Derbyshire from the fine grade lime-stone, and termed "BUXTON LIME." This can be obtained in truck loads delivered to any station in Great Britain and will often pay to use even at a slightly higher cost.

Slaking

Freshly burnt, or *Quick*, lime is necessary for all insecticidal purposes and no other kind will serve.

It should be in lumps with as little powder as possible. The powder in commercial samples of lime is due to the air slaking of the lumps on exposure, and consists largely of chalk or carbonate of lime which has little or no efficiency, especially if used for the preparation of Lime-Sulphur, Bordeaux, Arsenate of Calcium, or for water-softening purposes.

The first operation in the use of lime is to slake it. On treatment with water, lime combines chemically with about one-third its weight of water forming slaked lime or "calcium hydroxide." In order to thoroughly slake lime in a short time, a minimum of water must be used so that the heat formed by the chemical action keeps the whole mass at a high temperature. The lime is placed in a tub or suitable vessel and a little water added. When heat commences to be developed small additions of water may be made. The lumps then rapidly crumble and on stirring a thick cream is produced—"milk of lime." The remainder of the water may now be added, stirring well with a wooden paddle. It should then be strained through sacking before use, to get rid of any coarse or gritty particles.

If the mixture is allowed to settle the clear solution of lime in water contains about 0·22 per cent. of dissolved lime (as quicklime).

Action on Plants

Lime, if freshly prepared and sprayed on to young leaves, has a considerable scorching action. It may however be safely applied to the shoots before the buds are fully opened in early spring.

Action on Insects

Lime is employed either alone or with the addition of salt, silicate of soda, or other adherent for sealing up eggs of insects so as to prevent their hatching out, and also to protect the buds against insect attacks such as weevil etc.

2. Method of Use

Strength of Spray

1. Lime only.

Per 100 gallons of spray.

2 *cwt. lime.*

Slake about four to six hours before using. After slaking, add 30 gallons of water at once and allow to stand. (It will not be too long if it is allowed to remain overnight but it should be well covered up.) When spraying, one pailful of the above paste may be taken to two pailfuls of water.

If possible it is best to use a strainer of about 16 to 20 meshes to the inch. In any case strain through sacking.

2. Lime and Salt.

Per 100 gallons of spray.

2 cwt. lime.

Slake as above, add 30 gallons of water and then 25—40 lbs. of salt. Stir till dissolved and use as above.

3. Lime and Silicate.

As above with the addition of 10—12 lbs. of silicate of soda (water-glass) per 100 gallons of wash.

When to Spray

As late as possible in the dormant season. It is still safe to apply when the buds have commenced to open (see figures 244—247). An added advantage of spraying with lime is that it delays the opening of the buds for a few days and thus protects them against late frosts.

How to Spray

A powerful machine is required, preferably fitted with a special spray nozzle (see fig. 254, page 636). The whole of the tree should be sprayed, the branches and terminal buds having a good coating all over.

3. Scientific

Chemical Composition

Lime, when pure, consists of the oxide of calcium, CaO.

Varying proportions of silica and other metals are usually present.

Properties

Hard lumps; caustic; rapidly absorbs carbon dioxide from the air, forming calcium carbonate (chalk), $CaCO_3$.

On treatment with water, combines vigorously with one molecule, forming $Ca(OH)_2$.

LIME-SULPHUR

Employment

In addition to its use as a fungicide (see page 612) several authorities are agreed that it lessens aphis attack if used in the late winter. Actual trials have not shown it to have any reliable killing action on eggs of insects, and the solution of its apparent beneficial action is still to be discovered. In addition it has been found fatal to the

scale insect both upon apples and other fruit trees, and on the brown scale of currants. Trees are sprayed for this purpose during the dormant season.

Strength of Spray

As for fungus diseases, see page 614.

LIVER OF SULPHUR

Description

For a full description, see under "Fungicides," page 624. Liver of Sulphur has been found useful against RED SPIDER.

It must be used with soft soap, sufficient being present to neutralise the hardness of the water and about 3—4 lbs. to 100 gallons *extra* ("free soap").

Great caution must be used in spraying with Liver of Sulphur as it varies so widely in composition (see page 624). It is liable to be very caustic, and in this condition will burn the leaves of tender plants if used in strong solutions. Growers should insist on having the POTASH salt, as a good deal of so-called Liver of Sulphur has been the *sodium* compound. This is likely to be much more injurious to the plant than the former.

Method of Use

For red spider (on gooseberries, hops, etc.) in the spring or summer, use 2—4 lbs. of Liver of Sulphur to 100 gallons of water and 3—4 lbs. of *free soft soap* as above (see also page 454).

It is better to employ a compound wash of paraffin emulsion with Liver of Sulphur and Nicotine as given under the description on page 379.

LONDON PURPLE

See also Paris Green, Arsenate of Lead, etc.

1. General

Employment

As for arsenate of lead (for destroying all leaf-eating insects).

Description

"London Purple" is a waste product from dye works, and is an impure form of calcium arsenite (*not* arsenate). It contains about

75 per cent. of this substance and also soluble arsenic to a considerable extent.

Even with pure calcium arsenite the solubility is sufficiently marked to produce severe scorching of the leaves under unfavourable conditions. For this reason, although this is a cheap poison and to that extent attractive, it is strongly advised to use the safer and equally efficacious arsenate of lead whenever this is obtainable.

Properties

All the arsenites and "white arsenic" are **very poisonous**, much more so than the arsenates, and they must be very cautiously handled in consequence[1].

Preparation

Calcium arsenite may be prepared by treating **2½ lbs. of quicklime** with sufficient water to slake it and then adding 3 gallons of water and **1¼ lbs. of white arsenic** (arsenious oxide, As_2O_3) and boiling for about 30 minutes. The rest of the water is then added, and the mixture is ready for spraying. Using the waste product, London Purple, it should be made up with an equal amount of quicklime before spraying, but the mixture need not be boiled.

2. Method of Use

Strength of Spray

London Purple ½ lb.
Quicklime ½ lb. } Water 100 gallons.

Slake the lime with sufficient water in a pail, mix in the London Purple and pour into the bulk of the water, stirring well. For the preparation of pure calcium arsenite spray, see above.

When and How to Spray

See remarks under arsenate of lead, page 402.

Quantity of Spray Used

As for arsenate of lead, page 402.

[1] For treatment in cases of poisoning see Appendix VII, page 705.

NAPHTHALENE

See also Kainit, Bisulphide of Carbon, Soot and Gas Lime

1. General

Employment

Naphthalene is the most successful substance yet found as a **soil insecticide** or fumigant for killing all harmful insects in the ground. Such insects may be in the form of larvæ (grubs, maggots, caterpillars), pupæ or adult insects. The following is a fairly complete list:

Insects [injurious to fruit] which live in the soil during the winter:—

1. LARVÆ.

   Caterpillars: Swift.

   Grubs: Leaf Weevils, Nut Weevil, Raspberry Weevil, Red-Legged Weevil, Ground Beetles, Raspberry Beetle (often), Cockchafer, Rose chafer.

   Maggots: Apple Sawfly, Gooseberry and Currant Sawfly, Slug worm, Nut Sawfly, Plum Fruit Sawfly, Plum Leaf Sawfly, Social Pear Sawfly, Pear Midge.

   Aphides: Woolly Aphis.

2. PUPÆ.

   Of Moths: Buff Tip, Clouded Drab, December, Dot, Hawk, March, Mottled Umber, Peppered, Winter.

   Of Weevils and Beetles: Twig-cutting weevil. All the above described under "grubs" occur.

   Of Flies and Sawflies. All the above described under "maggots" occur.

3. ADULT INSECTS.

   Ground Beetles, Woolly Aphis, Big Bud Mite (?), Eelworm, Slugs (often).

Description

Napthalene is a production of the distillation of coal. When pure, it occurs as a glistening white solid, either in flakes or lumps, or moulded into cakes, sticks or balls. It possesses a somewhat pleasant characteristic smell.

It forms the basis of most, if not all, of the advertised soil insecticides, which consist of naphthalene ground up with ashes or clinker or other gritty materials.

Its action is due to the fact that it slowly vaporises ("sublimes") at the ordinary temperature and this vapour has a stupefying action on insects, resulting, under prolonged treatment, in death.

In addition to its use as a soil insecticide it is largely employed as a preventive of moths in clothes, and as a "disinfectant" in lavatories, etc.

Simple Tests

The best test for the grower to use is to place a small amount in a warm place and see if any residue is left which will not vaporise off. It is liable to contain tar oils through not being sufficiently refined, but these should not exceed 2—3 per cent. Paraffin wax may be fraudulently added, and this is an objectionable impurity, as it prevents the free vaporisation of the naphthalene.

Commercial Brands

It is best to buy a fairly pure product and to insist on the percentage of naphthalene present being stated.

It should be as finely ground as possible and not contain lumps.

2. Method of Use

When to Apply

Any time during the winter months is a suitable time. For the pupæ of the winter moth, the application must be made in the autumn.

If the trees are banded in the autumn, it is unnecessary to use naphthalene for this purpose.

How to Apply

The powdered naphthalene is best mixed before application with about double its weight of fine soil or ashes. It should then be dug fairly deeply in around the trunks of the trees as far over as the spread of the branches.

Fairly deep digging-in is necessary, as the vapour of the naphthalene will not penetrate downwards to any extent.

Quantity of Material Used

1. For general application to land, the amount to use for efficiency is about $2\frac{1}{2}$ to 3 cwts. per acre.

2. For application to trees, as under:

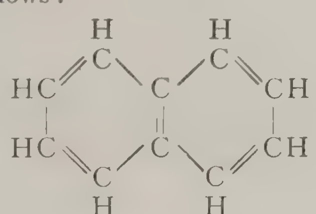
Spread of trees, feet	Weight of naphthalene per tree, lbs.	Cwts. per acre. Distance apart in feet							
		10	12	15	18	20	24	30	40
7	$\frac{1}{2}$	2	$1\frac{1}{2}$	1	$\frac{2}{3}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{8}$
10	$\frac{3}{4}$		$2\frac{1}{4}$	$1\frac{1}{2}$	1	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{8}$
15	$1\frac{1}{2}$			3	2	$1\frac{1}{2}$	1	$\frac{2}{3}$	$\frac{1}{3}$
20	$2\frac{1}{2}$				3	$2\frac{1}{2}$	$1\frac{1}{2}$	1	$\frac{1}{2}$
25	$3\frac{3}{4}$					$3\frac{3}{4}$	$2\frac{1}{2}$	$1\frac{3}{4}$	$\frac{3}{4}$
30	5						3	2	1
35	7							3	$1\frac{1}{4}$
40	9							4	2

3. Scientific

Chemical Composition

Naphthalene is a hydrocarbon of the aromatic series $C_{10}H_8$.

Its structure is as follows:



Properties

Commercial naphthalene should melt at 79° C., boil at 217°—218° C. and volatilise without leaving any residue.

Tests for Adulteration

1. When heated with concentrated sulphuric acid at 170°—200° C. the colour should not become a darker shade than grey or faintly purple.
2. It should volatilise without residue (or in commercial samples not over 20 per cent. residue).

Insecticidal Value

The author has found that pure naphthalene, at normal temperatures, loses 0·18 per cent. of its bulk in 24 hours by vaporisation.

In terms of the surface area exposed to air, it loses 0·01 gramme per square centimetre, or $\frac{1}{3}$ oz. per square foot every 24 hours.

NICOTINE

1. General

Employment

It is of the greatest value for destroying sucking insects, as aphis ("lice"), psylla ("suckér"), capsid bug, red spider, etc. In addition, leaf-eating insects, especially if soft-bodied, are killed if stronger solutions are used.

Description

Nicotine belongs to the class of substances known as *alkaloids.* These are very active poisons, obtained largely from plants. It occurs in tobacco in amounts varying in different species of plants from $\frac{1}{2}$ to 7 or 8 per cent.

Properties and Simple Tests

Nicotine, as it comes into the grower's hands, is a yellow to dark brown fluid with a very pungent odour. It is a MOST VIOLENT POISON. Thus a single drop placed on the tongue of a dog is said to be fatal. The greatest care should be taken not to inhale the fumes, especially in pouring it out of the cans or drums in hot weather[1]. There are no simple tests for nicotine which the grower can apply.

The hydrometer is of no service, as the specific gravity of nicotine is very close to that of water, which is one of the likely adulterants. Notes on the analysis are given on page 441.

Preparation

Nicotine is manufactured by three principal firms in this country. To cope with the increasing demand for it, others are now installing plant for this purpose. These remarks apply to the so-called PURE NICOTINE 95—98 PER CENT.

[1] In cases of poisoning by nicotine fumes, a draught of strong coffee, or brandy, followed by deep breathing in the open air are good. Camphor is also good as an antidote. If the nicotine is swallowed, an emetic of mustard and water should be given at once, and the patient kept lying down. In severe cases, the hypodermic injection of $\frac{1}{20}$ grain of strychnine is advised.

In America a cruder form is produced by a special patented process. This is termed BLACK LEAF 40, and is guaranteed to contain an equivalent of 40 per cent. of nicotine.

Pure nicotine

A guarantee of strength should be insisted upon, and, if any quantity is bought, it will be well to have a sample analysed.

The most likely adulterant is water, but there may be also ammonia, or pyridine added fraudulently. The latter is especially difficult to detect, and the analyst should be prepared to guarantee a sample *free from pyridine*[1].

Black leaf 40

In this compound the nicotine is not in a free condition, but combined with sulphuric acid. It is therefore liable to remain on fruit sprayed with it instead of rapidly evaporating off as pure nicotine does. A certain amount of crude material from the tobacco is also present. It is however cheaper than the pure nicotine and efficient for many purposes. An analyst should be asked to specify the *percentage of nicotine present.*

Action on Plants

Nicotine, being itself a "vegetable substance," has little or no action on plants at the strength required to kill insects, and may be safely employed even on the most delicate foliage.

Action on Insects

Nicotine is perhaps the IDEAL INSECTICIDE for all sucking insects. It is extremely efficient, a rapid and uniform kill being assured at effective strengths, especially in the presence of soft soap as a carrier.

Caterpillars are also killed by using an increased proportion of soft soap and nicotine, but for this purpose they *must be hit by the spray.* The nicotine, unlike the arsenates, will not remain as a poison on the leaf, but rapidly evaporates off.

[1] The author has worked out a reliable method for determining the amount of pyridine in nicotine (see *Analyst*, 1919, 44, 363).

2. Method of Use

Strength of Spray

4 to 5 ozs.[1] of pure nicotine **per 100 gallons** of wash is quite efficient for APHIS ("lice," "greenfly," etc.) and PSYLLA (apple sucker). There should also be present 2 *to* 4 *lbs. of free soft soap* in solution (i.e. soap over and above that required to "kill" the hardness of the water (see page 458)).

For the CAPSID BUG, a rather higher strength of nicotine is required; **6 to 7 ozs.** with 4 *lbs. of free soft soap* (page 454) has been found to give very efficient results.

For CATERPILLARS, to ensure a good effect, it is safest to use from **10 to 12 ozs.** of nicotine with 5 *to* 6 *lbs. of free soft soap.*

Many growers use nicotine along with arsenate of lead and without soap. In the author's opinion this is only advisable if labour difficulties prevent a separate spraying with nicotine and soft soap. This is for two reasons:

1. The "fog" type of spray used for applying arsenate of lead is unsuitable for applying nicotine.
2. The effect of nicotine is increased enormously when used with soft soap.

Procedure

The soft soap is prepared by boiling in the usual manner. The hardness of the water should be known, so that the correct amount of "free soap" is obtained in the final wash. The nicotine is then carefully measured out in an 8 *oz. measuring glass* (procurable at a druggist's—as used in photography), added to the diluted soap solution, and well stirred.

How to Spray

With a high pressure pump and medium[2] nozzle, using plenty of solution, and giving a powerful spray.

Quantity of Spray Used

The following figures (page 440) are compiled from practical routine spraying and are a good average to work upon. They are based upon a normal, early summer leafage on the trees.

[1] This quantity can be measured as fluid ounces, since 1 fluid ounce of nicotine weighs roughly 1 oz.

[2] Adjustable nozzles with collar screwed up (see page 634, figs. 250, 251).

Fig. 214. Capsid bugs (from Cambridge) magnified; inset, natural size.

Spread of trees (feet)	Dilute wash required per 100 trees (galls.)	Nicotine 95—98 per cent. required per 100 trees				
		Strength as under per 100 gallons of wash				
		4 oz.	6 oz.	8 oz.	10 oz.	12 oz.
7	260	10½ oz.	15½ oz.	1 lb. 5 oz.	1 lb. 10 oz.	1 lb. 15 oz.
10	350	14 oz.	1 lb. 5 oz.	1 lb. 12 oz.	2 lb. 3 oz.	2 lb. 10 oz.
15	610	1 lb. 8½ oz.	2 lb. 2½ oz.	3 lb. 1 oz.	3 lb. 13 oz.	4 lb. 5 oz.
20	960	2 lb. 7 oz.	3 lb. 10½ oz.	4 lb. 14 oz.	6 lb. 1½ oz.	7 lb. 5 oz.
25	1470	3 lb. 11 oz.	5 lb. 8½ oz.	7 lb. 6 oz.	9 lb. 3½ oz.	11 lb. 1 oz.
30	2100	5 lb. 4 oz.	7 lb. 14 oz.	10 lb. 8 oz.	13 lb. 2 oz.	15 lb. 12 oz.
35	3000	7½ lb.	11¼ lb.	15 lb.	18¾ lb.	22½ lb.
40	3800	9½ lb.	14¼ lb.	19 lb.	23¾ lb.	28½ lb.

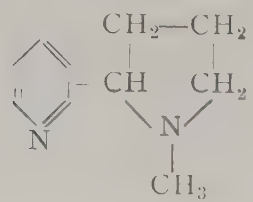
To ascertain the amount of wash and of nicotine required PER ACRE the above quantities must *be multiplied by the following factors:*

Distance of trees apart in feet	Factor
6	12·1
10	4·35
12	3·02
15	1·93
18	1·34
20	1·08
24	·75
30	·48
40	·28

3. Scientific

Chemical Composition

Nicotine has the following composition[1]:



or n. methyl pyridyl pyrrolidine.

[1] Synthesised by Pictet in 1904.

Properties

Nicotine is a strongly basic liquid, boiling at 247° C. and of specific gravity 1·011 at 15·5° C.

It is very soluble in water, and also in most oil solvents.

Has a pungent odour and is a violent poison.

Tests for Adulteration

It is liable to adulteration with water, alkalies (including ammonia) and especially pyridine. Adulteration with the latter is difficult to detect. The refractive index gives a good indication of adulteration (see Fryer, *Analyst*, 1919, **44**, 363 for methods of analysis and determination of pyridine). A table of refractive indices of pure nicotine calculated by the author is given on page 702.

PARAFFIN

Employment

Chiefly as an **emulsion** (see page 417) or as *soluble paraffin* or *paraffin jelly* for aphis ("green fly"), including woolly aphis, and for caterpillars. It is also used with caustic alkali for the destruction of insect eggs during the dormant season.

Description

Paraffin oil is one of the fractions from the distillation of crude petroleum or from shale oil. The lighter fractions of petroleum are known as "naphtha," including "petrol" and other naphthas. The fractions heavier than paraffin oil are used as lubricating oils. Between paraffin oil and lubricating oil there is a fraction which is too heavy for the one and too light for the other. This is called "Solar Oil" or "Solar Distillate" and has been found especially suitable for emulsions for spraying purposes[1].

Further particulars will be found under "Emulsions," page 417.

[1] See Pickering, *Woburn Reports*.

PARIS GREEN

(Also termed "Emerald green," "Schweinfurt green," "Imperial green")

See also Arsenate of Lead, Arsenate of Calcium, London Purple, Hellebore, Pyrethrum, Chromate of Lead

1. General

Employment

As for arsenate of lead, for the destruction of all leaf-eating insects (caterpillars, etc.).

Description

Paris green, or aceto-arsenite of copper, is a fine emerald green dye. It is sold in powder and in paste form, the latter containing about 75 per cent. of the dry substance. It is a powerful caterpillar poison, the latter containing about 24·2 per cent. of arsenic (i.e. 37 per cent. in terms of As_2O_5 as compared with arsenate of lead paste, 12—20 per cent.). It has, however, been proved to have dangerous scorching tendencies[1] on foliage. The injury is lessened but not removed by the use of lime with Paris green, and it is best to always use lime when this spray is employed. When it can be obtained, however, it is preferable to use arsenate of lead.

2. Method of Use

Strength of Spray

1. POWDER.

   $\frac{1}{4}$ to $\frac{1}{2}$ lb. Paris green.
   $\frac{3}{4}$ lb. quicklime.
   100 gallons of water.

Slake the lime with a small quantity of the water, stir in the Paris green and add to the bulk of the water. Stir well.

2. PASTE.

   5 to 10 ozs. Paris green.
   10 ozs. quicklime.
   100 gallons of water.

Proceed as before.

[1] Thus Pickering found 75 per cent. of apple trees decidedly scorched, using 8 ozs. of the dry substance to 100 gallons of water.

When and How to Spray

Spray as soon as caterpillars and other leaf-eating pests are seen. The spray must be "fogged on" as with arsenate of lead (see page 402), a high pressure and fine nozzle being used and excess of spray avoided.

Quantity of Spray Used

The following represent average figures:

Spread of trees, feet	Amount of diluted spray per 100 trees, gallons	Weight of Paris Green, per 100 trees	
		powder, lbs.	paste, lbs.
7	200	$\frac{3}{4}$	1
10	270	1	$1\frac{1}{4}$
15	460	$1\frac{3}{4}$	$2\frac{1}{4}$
20	720	$2\frac{3}{4}$	$3\frac{1}{2}$
25	1120	4	$5\frac{1}{4}$
30	1500	$5\frac{1}{2}$	$7\frac{1}{4}$
35	2200	8	11
40	2800	$10\frac{1}{2}$	14

3. Scientific

Chemical Composition

Paris Green is a double arsenite and acetate of copper:

$$3CuO\,As_2O_3Cu(C_2H_3O_2)_2 = 618.$$

Cu = 41·1 per cent.

As = 24·2 per cent.

Properties

A nearly insoluble, emerald green powder.

Very poisonous[1].

Tests for Adulteration

The best test for insecticidal purposes is the percentage of arsenic present, both in a soluble and insoluble form.

[1] For first aid treatment, see page 705.

PYRETHRUM

1. General

Employment

Has a limited use against soft-bodied insects. It acts as a fumigant, giving off a poisonous vapour.

Description

Pyrethrum is cultivated in Japan and other parts of Asia. Two plants are mainly used for the preparation of the powder.

Pyrethrum cinerariæ folium.

Chrysanthemum coccineum.

The flower heads are the only parts of the plant containing the poisonous principle. They are collected, dried and powdered, and the powder is either used alone, or mixed with three times its weight of flour, or with flowers of sulphur.

Properties

The powder soon loses its potency if exposed, and it should be freshly ground or kept in sealed, air-tight packages.

2. Method of Use

Strength of Spray

The powder is generally used, either alone, or in admixture with flour. Extracts may also be employed using soft soap solution or alcohol in which to macerate the flowers.

Preparation of Spray

The soap extract is prepared as follows:

Per 100 gallons of wash.

Soft soap 10—15 lbs. Boil with 4—5 gallons of water until dissolved, and add 15 lbs. Pyrethrum powder (fresh). Stir and make up to 100 gallons with cold water.

Quantity of Spray Used

As for Soap (page 456).

Remarks

The soap formula is an excellent one and would be in great favour if the flowers could be relied upon for freshness and the price were sufficiently low to compete with other insecticides.

PYRIDINE

1. General

Employment

It has been used occasionally as a contact insecticide, especially for *capsid bug*.

Description

Pyridine is a colourless liquid, dissolving in water, and having an extremely disagreeable and pungent odour. It rapidly causes headache when inhaled. It is only a weak insecticide and although quite cheap it tends to injure the foliage when used at the strength required to kill aphis or capsid. As far back as 1905, the author made a large number of tests with this substance, since, resembling nicotine as it does in many ways, it appeared a promising insecticide. These have been repeated more recently, but the results have in all cases proved disappointing[1].

Pyridine has been used as *an adulterant of nicotine*, and as it is very much cheaper and extremely difficult to detect, it offers a great inducement to unprincipled people for this purpose (see page 441).

2. Method of Use

How to Spray

As for nicotine.

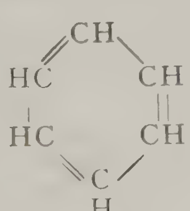
Quantity of Material Used

Pyridine, in order to have any effect, must be used at a strength of **15—16 ozs. per 100 gallons** of wash, along with 3—4 lbs. of *free* soap (see page 454). At this strength it is liable to injure the foliage, especially when weather conditions are unfavourable.

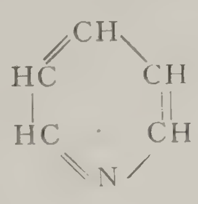
3. Scientific

Chemical Composition $C_6H_5N = 91$.

Pyridine consists of benzene in which one of the CH groups is replaced by Nitrogen.



Benzene



Pyridine

[1] One series of tests with pyridine on capsid bug in Cambridge appeared fairly satisfactory, but the results were not confirmed and there is risk of injury to the plant if used above a definite strength.

Properties

Colourless, pungent liquid, soluble in water, and very stable.

Specific gravity 1·003 (0° C.). B.P. 114·8° C.

Tests for Adulteration

May be tested for water by titration with standard acid, using methyl orange as indicator. Each c.c. of normal acid = 0·091 gramme pyridine.

The refractive index is also a good test for purity (see table by author, page 703, and also *Analyst*, 1919, **44**, 363).

QUASSIA

1. General

Employment

For destroying *sucking insects* such as aphis (green fly) and psylla (sucker) in a solution of soap.

Description

Quassia occurs in the form of billets or chips of wood from the Quassia tree. There are two varieties of wood:

1. JAMAICA QUASSIA (*Picræna excelsa*): yellowish white, coarse texture, billets usually over 5 inches in diameter.
2. SURINAM QUASSIA (*Quassia amara*): deeper colour than above, harder and heavier than Jamaica, billets generally under 3 inches in diameter.

The wood is intensely bitter owing to its containing the bitter principle, known as *quassin*, which is poisonous to aphis and other insects. The wood is more efficiently extracted by hot than cold water, and the extraction is more thorough if a small quantity of an alkali (such as carbonate of soda) is present.

Commercial Data

Quassia occurs on the market in two forms:

1. Natural.
2. Kiln dried.

It is always better and safer to buy the kiln dried, as the drying prevents fermentation and deterioration of the wood. As the quassia wood loses a good deal of moisture in the process of drying, the cost is correspondingly higher. Since however it contains

much more, weight for weight, of the active principle, *quassin*, it is not in reality more expensive.

Chips should not be kept too long before use, and should be stored in a dry building. It is better to buy the billets, and chip with a machine as required.

Quassia *extract* occurs on the market as a treacly, black fluid. It is usually supposed to be about 100 times as strong as the wood, but in practice it is subject to great variation and growers should make a trial of a sample before buying any large bulks.

Action on Insects

Quassia is a distinct poison to aphis, psylla and other soft-bodied sucking insects. Its action is not so rapid as that of nicotine, which kills in a few hours at the lower strengths (page 437). It appears to have the property of causing the lice to relax their hold on the leaves and fall off the plant, thus leaving the leaves cleaner than other insecticides. This is probably because a certain amount of quassia is absorbed by the plant and renders the sap distasteful. Quassia is also credited by many growers with preventing further attacks of fly for some days after spraying.

Not only is quassia quite harmless to plants, but it appears even to have a distinct stimulating action, especially in the case of hops.

2. Method of Use

Strength of Spray

Very varied strengths have been recommended. This is probably due to the different condition and quality of the chips used.

If fresh kiln dried chips are used, and the method of extraction given below is followed, 5 lbs. per 100 gallons of diluted wash should be a sufficient quantity. An adequate amount of *soft soap* must also be employed. The amount depends upon the hardness of the water. From 3 to 4 lbs. of "free soap" should be present (see page 454).

Preparation of Spray

It is quite certain that many growers fail to extract anything like all the "goodness" from the quassia chips. The author has often found rejected chips which contain a high percentage of *quassin*

left in them. In order to extract in the most efficient way, boiling water should be used, and a double treatment should be given. For this purpose two tanks are employed for treatment of the chips and the chips should be boiled about two hours in the first tank. The liquor is then strained and added to the soft soap solution.

When the water has boiled for about 10 minutes, a small quantity of carbonate of soda is added (at the rate of about a handful to 100 gallons or roughly ·05 per cent.). This aids the dissolving out of the quassin, but more than this must not be used, as the foliage may suffer. After the chips have been once treated and the liquor strained off, they should be boiled a second time with an equal quantity of water. This time no carbonate of soda is added. At the end of about an hour, the liquor is strained, and added to a fresh lot of chips in the other tank, and the boiling continued as at first for two hours with an addition of carbonate of soda. The original chips are now thrown away. In this way, each lot of chips is twice extracted before it is rejected.

When to Spray

Both for hops and fruit, but particularly for the former, it is best to spray directly any signs of aphis ("fly" or "lice") are seen on the leaves, as by so doing a serious attack is often prevented.

How to Spray

Plenty of solution must be used, and a high pressure so that the aphides are "hit." On the other hand the spray should be fine enough to reach leaves which are not directly in the "line of fire" but hidden behind other leaves and branches (see page 632).

Quantity of Spray used

As for Soft Soap (page 456).

3. Scientific

Chemical Composition

Not fully investigated.

The bitter principle from Jamaica quassia has been termed *picrasmin*.

There are apparently two forms:

α. Picrasmin $C_{35}H_{46}O_{10}$ melting at 204° C.

β. ,, $C_{36}H_{48}O_{10}$,, ,, 209° C.

The percentage in the chips appears to vary from 0·75 to 1·0 per cent.

Properties

The *picrasmin* or *quassin*, the active principle of quassia, is a white crystalline powder, sparingly soluble in water, more soluble in hot and alkaline solutions. Readily soluble in *chloroform*, by which it can be extracted from acid solutions.

It gives a brown coloration with weak ferric chloride solution.

Its solutions are intensely bitter.

Tests for Strength

The best method is to extract the chips with a dilute boiling alkali solution, acidifying with sulphuric acid, and shaking out with chloroform. Separate off the chloroform and evaporate to dryness. Weigh the residue so obtained.

A less satisfactory method is to precipitate with a solution of Tannic Acid, and then to filter and weigh the precipitate.

Insecticidal Value

The insecticidal value of pure *picrasmin* (or *quassin*) appears to be about a half to a quarter that of pure nicotine.

It however takes a much longer time to kill than the latter.

Remarks

The bitter principle, *picrasmin*, has not yet been extracted on the commercial scale.

If a cheap and suitable method of extraction could be found, the pure substance would be extremely convenient to use in place of the present tedious and often wasteful method of chip-boiling.

SAPONIN

See also Soap, Water

1. General

Employment

As a wetting and spreading agent for causing sprays to wet the leaves and insects, and so bring insecticides into contact with the surfaces of the insect and fungus pests.

Description

Saponin occurs when pure as a white powder. It varies in its chemical composition and the various kinds are obtained from

several sources. Thus the *Quillaia* or *soap bark*, and the root of the *soapwort*, both contain varying amounts of Saponin. Several other plants are also known to contain it.

Saponin is especially of use where soap could not be used, owing to chemical action. It has recently been very successfully employed with LIME-SULPHUR to ensure better contact and penetrating power when spraying for fungus attacks. (See page 619.)

In this case soap would be useless, as it immediately curdles in solutions of lime-sulphur, forming an insoluble lime soap, and stopping up the sprayer.

In every case where soft soap can be employed it is preferable to saponin for spraying, because, in addition to being an efficient spreading and wetting agent, it has also a definite killing action on insects.

For the above reason, saponin is of great use when testing the action of insecticides since one can be certain that the mortality is due entirely to the insecticide and not partially to the soap.

In the case of very hard waters, where water softeners cannot be employed, it is preferable to use saponin, as the hardness of the water has no effect on its spreading power.

Commercial Brands

Pure saponin is obtainable from chemists as a fine white powder. It is however much too expensive for agricultural use, and the grower is advised to use a commercial preparation by a well-known firm[1]. This is in the form of a liquid containing 10 per cent. of pure saponin. In such a form saponin is only slightly dearer to use than soft soap.

Action on Insects

Saponin has little or no action on insects in dilute solutions.

2. Method of Use

Strength of Spray

Per 100 gallons of wash.

Use **2 to 5 lbs. saponin** (pure) or **2 to 5 gallons** of **10 per cent solution**[2].

[1] The Yalding Manufacturing Co., Ltd., Yalding, Kent.

[2] See note above.

To this solution, before spraying, the insecticide must be added, and, in order to kill efficiently, more must be used than in the case of soap.

Thus, in the case of a very hard water, 6—7 ozs. of nicotine should be used per 100 gallons of wash with say 3 to 4 gallons of 10 per cent. saponin solution. For use with lime-sulphur solutions, see page 619.

Preparation of Spray

Stir in the correct amount of solution into the bulk of the water, together with the insecticide.

In the case of the pure powder, dissolve first in about 5 gallons of water and stir this into the bulk of the water.

When and How to Spray

As for soap, page 455.

Quantity of Spray Used

As for soap, see page 456.

3. Scientific

Chemical Composition

The saponins are all glucosides of composition $C_nH_{2n-8}O_{10}$. The exact composition is not yet established, but upon decomposition they yield glucose and sapogenins.

Properties

Some of the saponins are very poisonous, others are almost harmless.

Bitter acrid taste.

Soluble in water, forming frothy solutions.

The pure substance is obtained by precipitating infusions of the bark and roots of plants with neutral and then basic lead acetate. The precipitates are decomposed and the saponin solutions evaporated and purified by solution in chloroform and precipitation by ether.

SOAP

See also Saponin, Water, Carbonate of Soda

1. General

Employment

Soap is an efficient, although a slow acting insecticide when used in sufficient quantity. It apparently acts by blocking the breathing pores of the insect and so causing suffocation.

Its main use however is to cause solutions of insecticides to "wet" the insects and penetrate into the breathing apertures.

Description

If water is sprayed upon the surface of a leaf it will be found that the small particles of the spray run together, forming large drops which do not wet the leaf surface and readily run off altogether. Some leaves show this effect to a more marked extent than others. It is found that certain substances, when added to the water, enable it to spread over the leaf surface[1]. The most effective of these is SOFT SOAP. Hard soap is also a good "spreader" but it is more liable to injure the plant.

Quite a small quantity of soft soap is effective for this purpose; thus using distilled or pure water 2 to 3 lbs. of soft soap per 100 gallons of the water is all that is necessary.

Unfortunately the water available for spraying purposes always contains some impurities– even rain water, which is the purest form of naturally occurring water. Many of these impurities destroy a proportion of the soap, forming a chemical compound with it which is thrown out of solution as a "curd." It is therefore necessary to use sufficient soap to remove these impurities, and "kill the hardness" before the soap can be reckoned on as having any effect.

The degree of impurities in solution, or the HARDNESS of the water available, is therefore a very important question in spraying, and it is discussed in detail below (page 458).

[1] The scientific explanation of this is that it is due to the reduction of the surface tension of the liquid.

Properties and Simple Tests

Soft soap is manufactured by boiling together CAUSTIC POTASH and OIL.

Almost any sort of vegetable, animal or fish oil may be used, but a mineral oil is in a different class altogether and quite unsuitable. Oils commonly employed are Linseed Oil, Bean Oil, and Cotton-seed Oil for the better grades, and Whale, Cod liver and Japan Fish or Herring Oil for the lower grades.

The boiling process is by no means an easy one and requires skilled supervision. It is thus not possible for a grower to make his own soap.

The better grades of soft soap are clear and transparent, of a light colour and almost without odour. They are firm in consistence without being stiff or leathery. In cold weather, or after being kept for some time, whitish specks, streaks, or small lumps appear in the soap. This is due to so-called FIGGING and the particles are the harder soaps crystallising out. It is no detriment to the soap in any way.

The lower qualities are of a darker colour and have often a pronounced disagreeable "fishy" smell. Such soaps often contain proportions of free caustic soda or carbonate of soda, which is liable to injure the tender foliage, e.g. that of hops.

All soft soaps, whether of high or low grade, should be clear and transparent.

Lower grade soaps often contain portions of ROSIN, and although this is not an adulterant in the sense that it is of no value, it reduces the quality and the soap is especially likely to be objectionable when used with hard water. In such cases a more or less sticky "curd" is produced which is likely to cause trouble in the nozzles of the spraying machine.

When soap is carefully made, it can be produced quite "neutral" or free from excess of potash. Such soaps are not so suitable for spraying purposes as those containing a certain amount of "*extra*" or "*free*" *potash*. The amount however must be carefully controlled and must not be allowed to exceed certain limits or there is a risk of scorching to the plant.

Soap containing free or *uncombined oil* is highly objectionable, being liable to clog the sprayers, but it is seldom met with in good makes.

HARD soap is made by boiling together various fats, such as tallow, palm, coconut, etc. and CAUSTIC SODA. It is more difficult to dis-

solve, forms a harder curd with water and is not so good for the plant nor as efficient as soft soap. Any excess of caustic soda is especially liable to cause injury to the plant.

During the great war, a substitute for soft soap was largely produced. This was manufactured with caustic soda, but specially selected oils were used and special precautions were taken to prevent any excess of caustic soda. These soaps proved fairly satisfactory but were nowhere equal in efficiency to the true potash soft soaps, and many insisted on using the latter even at the advanced prices. (The reason of the scarcity was, of course, the cessation of supplies of potash from Germany, only small quantities from other sources being available.)

Strength of Soap

Just as safety in spraying depends upon the high grade and quality of the soap, so its strength depends upon the percentage of fatty matter in the soap.

Since in the manufacture of soap the oil is split up, giving *fatty acids* which combine with the potash, it is usual to speak of the percentage of fatty acids in the soap.

Soft soaps may contain from 33 per cent. of fatty acids upwards. Good grades contain from 38 to 42 per cent., or even higher.

When over about 42 per cent. strength, soaps tend to become stiff and leathery in consistency and are very difficult to dissolve, even in boiling water. If rosin is present, this should be stated separately by the manufacturer and not given as fatty acids.

2. Method of Use

Strength of Spray

The amount of soap to use depends upon

1. The strength of the soap.
2. The hardness of the water.

A. Assuming a high grade of soap of say 40 per cent. fatty acid strength, and a soft water, the amount of soap necessary is

2—3 lbs. of free[1] soap per 100 gallons.

If about 3 lbs. of soap are necessary to "kill the hardness" this means

5—6 lbs. total soap per 100 gallons.

[1] See page 458 on hardness of waters.

B. With the same grade of soap and a **medium hard water,** more *free soap* is necessary, because the curd formed will require more soap to keep it in suspension and to prevent it sticking together and clogging the nozzles of the machine,

3—4 lbs. free soap per 100 gallons.

If about 5 lbs. of soap is required to "kill the hardness" this gives

8—9 lbs. total soap per 100 gallons.

C. Where **hard waters** are in question, the amount of free soap must still be further increased, say

4—5 lbs. free soap per 100 gallons.

To this must be added the quantity of soap required to *kill the whole of the hardness.* This may amount to a very large figure so that such waters take

10—15 lbs. total soap per 100 gallons,

or even more than this.

In such cases much can often be done by water softening and a great saving in soap accomplished. Of course it is always preferable to use a softer source of supply if this is in any way obtainable. For further particulars of water and the question of softening, see section on WATER (page 458).

How to Spray

Soap solutions, both with and without insecticides, are sprayed with considerable force[1], using a high pressure on the pump and plenty of liquid. The object is to reach and hit each insect and to coat it over with a complete film of fluid. Only by so doing can one be certain of covering the spiracles or breathing pores.

Quantity of Spray Used

The table overleaf is from the author's practical routine figures:

To ascertain the amount of soap required per acre, multiply the figures on page 456 by the following factors, according to the distance apart in feet.

Distance apart	Factor	Distance apart	Factor
6	12·1	20	1·08
10	4·35	24	·75
12	3·02	30	·48
15	1·93	40	·28
18	1·34		

[1] The adjustments for spray nozzles of the universal type is as on figs. 250, 251, page 634.

Spread of trees, feet	Dilute wash required per 100 trees, gallons	Soft soap (in lbs.) required per 100 trees (at strengths in lbs., as under, per 100 gallons)												
		3	4	5	6	7	8	9	10	11	12	13	14	15
7	260	7¾	10½	13	15½	18¼	21	23½	26	28½	29	34	37	39
10	350	10½	14	17½	21	24½	28	31½	35	38½	42	45½	49	53
15	610	18½	24½	30½	36½	43	49	55	61	67	73	79	86	92
20	960	29	38	48	58	67	77	87	96	106	115	126	134	144
25	1470	44	59	73	88	104	117	132	147	162	175	191	208	220
30	2100	63	84	105	126	149	168	189	210	231	252	273	294	315
35	3000	90	120	150	180	210	240	270	300	330	360	390	420	450
40	3800	114	152	190	228	246	304	342	380	418	456	494	532	570

3. Scientific

Chemical Composition

Soft soap consists of potassium oleate with a little stearate or palmitate, and varying quantities of linoleate, linolenate and clupanodonate. The latter acid predominates in soap made from fish oils.

It also contains small quantities of caustic potash free, and carbonate of potash.

Soda may be present in varying amounts. The percentage of combined potash varies from 7—8·5 per cent.

Properties

Soft, transparent, solid, yellow to dark brown in colour, and a sharp taste due to the free alkali.

Readily soluble in hot water, in which it should give a clear solution. Smell—odourless, or nearly so, to "fishy" or offensive.

Tests

1. The percentage of fatty acids yielded on solution and acidification with mineral acid.
2. Free and combined alkali.
3. Amount of soda present (by difference after subtraction of potash).
4. Silicate, starch or other filling material.
5. The character of the fats used, determined by an examination of the fatty acids obtained as above.

SOOT

Employment

When a better insecticide is not available, soot may be used as a surface dressing on ground round young fruit trees and bushes. In addition to being obnoxious to caterpillars and beetle larvæ, particularly when fresh, it serves to keep away snails and slugs.

Description

Soot varies a good deal in its chemical composition according to the kind of coal from which the smoke is obtained. It contains, as a rule, about 2–3 per cent. of sulphur, from 15 to 35 per cent. of carbon, and may also have a high proportion of tarry matter. Some kinds of soot contain over 6 per cent. of nitrogen and are therefore of manurial value.

WATER

Employment

Water is of itself an insecticide, as it is capable of drowning insects by flooding the breathing tubes. It is not however possible to achieve much good by spraying with water alone, as it will not adhere so as to wet the leaf surface and the bodies of insects. For this purpose a "spreader" is required, such as soft soap, saponin, etc.

Most insecticides are applied in solution or suspension in water. For this purpose, use has to be made by the grower of any source of supply which is convenient to hand. Such water always contains impurities in the form of more or less *mineral salts*.

On the amount of these present depends the HARDNESS of the water.

Hardness of Waters

For spraying with SOAP, or washes containing soap, a hard water is unsuitable, as the mineral salts destroy a proportion of the soap and more must be used to produce the desired effect. After the *hardness* of the water (which is due to certain lime and magnesia salts) is *killed* the soap is no longer destroyed, and a "lather" or "head" is soon formed on the top of the water. This is an evidence that there is FREE SOAP present. Without this free soap, it is useless to spray and expect any "spreading power."

Degrees of Hardness

It is very unfortunate, and apt to be confusing, that there are two figures commonly used for indicating the hardness of waters.

The old way of expressing the hardness is by "degrees" on **Clark's Scale**. This is nominally equivalent to grains of carbonate of lime (calcium carbonate) per gallon of water or *parts per* 70,000.

The modern way is to express hardness in PARTS OF CARBONATE OF LIME PER 100,000 and, as most analysts now express their results in this form, it has been adopted in this book.

The word DEGREES has been left out as misleading and the number alone is given. Thus, if a given sample of water shows mineral salts present equivalent to 15 parts of carbonate of lime per 100,000, it is spoken of as **having a hardness of 15.**

To convert the hardness numbers to the old "degrees" of Clark's Scale, it is fairly correct to multiply by 7 and divide by 10.

Thus a water of "hardness 15" should give a result of 10·5 degrees on Clark's Scale.

Variation in Waters

Not only do waters from different sources vary a great deal in hardness, but they are liable to differ considerably from time to time owing to evaporation by the sun, additions of rain water, feeding from springs, drainage from surrounding lands, etc.

It is therefore advisable for each grower to either have his water supply analysed[1] or to do a simple test himself before making up his spraying liquid.

Sources of Supply

The following are the chief sources of supply open to growers:

1. POND OR DITCH WATER.

   This class of water is liable to very great variations in hardness. Some pond waters, especially after heavy rains, are very soft, and others may be extremely hard, especially in chalky districts. Thus variations of from 3 to 30 are continually met with.

2. RIVER WATER.

   This is usually the very best kind of supply for the grower (excluding rain water, which is seldom available). It is subject only to slight variations and is usually soft, especially in the cases of the larger rivers.

   Thus the Medway tests on an average about 12 to 15 and the Thames 19 to 20. Tributaries of these rivers may be a little harder.

3. COMPANY'S WATER.

   As this is usually derived from springs, it is generally of medium hardness, although the services in different districts vary greatly. The individual supplies are not subject to variation to any great extent and an analysis can be obtained from the supply company concerned. There is also pressure in the mains and this saves the labour of pumping or carrying.

   The Mid Kent Co.'s water has a normal hardness of about 17 to 18.

[1] One well-known soap manufacturer does this free of charge.

4. Spring, Stream and Well Water.

This varies from medium to very hard, the latter especially in Kent, the water having passed through beds of chalk or chalky soil before issuing. They often exceed 50 hardness. It is not advisable to use such waters for spraying purposes unless no other source of supply is available.

5. Sea Water.

This is so heavily charged with mineral salts as to be quite unusable. Also the large amount of salt present makes it injurious to plants.

Soap required for softening different waters.

The following gives a table showing the amount of soap required to *kill the hardness* in water of various degrees of hardness:

Hardness of Water		Soap[2] (high quality) required to kill hardness, lbs. per 100 gallons
Number[1] (parts per 100,000)	Degrees on Clark's Scale	
0	0	0
1·2	·8	¼
2·4	1·7	½
3·5	2·4	¾
4·7	3·3	1
5·9	4·1	1¼
7·1	5·0	1½
8·3	5·8	1¾
9·5	6·6	2
11·8	8·2	2½
14·2	10·0	3
16·6	11·6	3½
19·0	13·1	4
21·3	15·0	4½
23·7	16·6	5
26·1	18·2	5½
28·4	20·0	6
30·8	21·5	6½
33·2	23·3	7
35·5	25·0	7½
37·9	26·5	8
40·3	28·2	8½
42·6	30·0	9
45·0	31·5	9½
47·5	33·2	10

[1] See page 458.

[2] Of say 40 per cent. fatty acids (see page 454).

Softening water for Spraying

It is very desirable for the grower to use any means he can to soften his water before the addition of soap or soap washes, as by so doing a great saving can be made, particularly in the case of hard waters. The ordinary process of water softening is however not usually feasible, as it involves the use of tanks and filters, and time is required for the water to settle before use.

In particular cases it may be possible that the requisite plant is available, and the water can then be thoroughly softened. The usual method is to add a proportion of milk of lime or lime water, then to settle or filter, and afterwards to add a measured amount of caustic soda or carbonate of soda and filter. The amounts of each must be carefully adjusted in the case of each water supply. Full information can be obtained from the many text-books on the subject.

A modern and extremely efficient softening process is by means of a substance called "Permutit" which removes all hardness from water on merely pumping the latter through a layer of the material. It would probably pay large growers to install a small plant.

It is however possible to effect a considerable softening with some samples of water by the use of a solution of carbonate of soda ("washing soda"). This is a very simple and cheap method and should be used wherever the water is hard. It is however very important not to exceed the required amount as, by so doing, severe scorching to the foliage has in the past resulted. The amount to use in each case may be gauged fairly accurately if the hardness of the water is known, as follows:

Carbonate of soda required for softening water.

Rule: Divide the hardness number[1] by 2, and call this figure ozs. of carbonate of soda crystals. This is the right amount for 100 gallons of the water.

The crystals should be dissolved in a little (preferably hot) water and the solution stirred into the bulk of the water. Allow to stand for at least half an hour before adding the soap for spraying.

Example:

Some water from a pond was sent to be analysed, and tested 26 hardness. It therefore required 13 ozs. of crystal carbonate of soda per 100 gallons to soften.

[1] See pages 458, 460.

In many cases, especially where the water consists largely of magnesium salts, carbonate of soda will not effect much softening. In such cases it is preferable to use first a softener consisting of a cheap soapy material, so as not to waste good soap. A patent for this idea has been granted to a Kent firm of insecticide manufacturers[1]. The softener is first stirred into the bulk of the water, and the soap or wash is then added.

In the case of excessively hard waters, where no other source of supply is available, it is best to use **saponin** in place of soap. This will be less expensive than the amount of soap which would be required, and is unaffected by the hardness of the water.

[1] Yalding Manufacturing Co., Ltd. The article is termed "Potassine Water Softener."

SECTION VI

BENEFICIAL INSECTS

SECTION VI

BENEFICIAL INSECTS

CHAPTER 27

It might well be thought that the fruit grower owes nothing but a grudge against the whole insect world, for the damage and destruction of his crops. This is however by no means the case. Indeed it is even questionable if a fruit grower would get any crop at all without insect agency.

Of the first importance are those insects which ensure fertilisation of the blossom by conveying pollen from one flower to another. Of

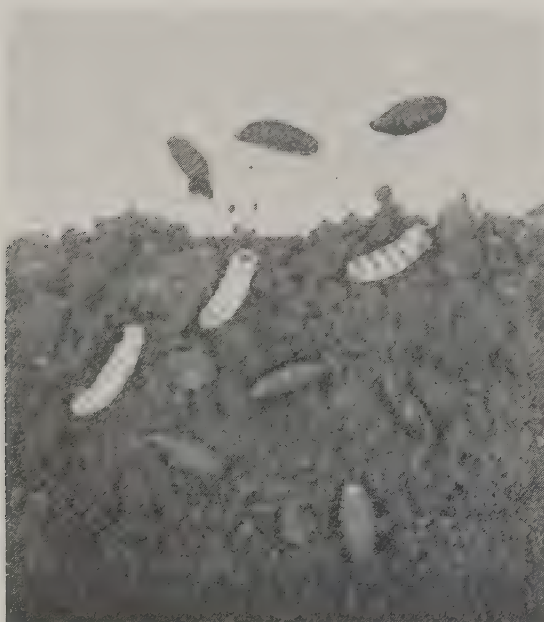


Fig. 215. Winter Moth pupæ and three parasitised larvæ which failed to pupate. Natural size.

these, the **bees** are by far the most valuable, and benefit has often been derived by keeping hives of bees in or near orchards. Many other insects also effect pollination though less systematically.

In spite of much prejudice **wasps** are without doubt beneficial to a considerable extent, some varieties effecting pollination and others

living largely upon other insects. They are however a great nuisance when, as frequently happens, they attack ripe fruit.

The remaining classes of beneficial insects all assist the grower by preying upon insect pests. Although, unless in exceptional cases, they cannot be relied upon to clear off an attack, they nevertheless do an extremely important service in diminishing the number of adults, and so keeping the pest within bounds[1]. Thus, in the present year, the author found a very large percentage of the Winter Moth caterpillars attacked by an ICHNEUMON fly, and none of these were able to pupate, being killed just as they reached their full growth (see fig. 215).

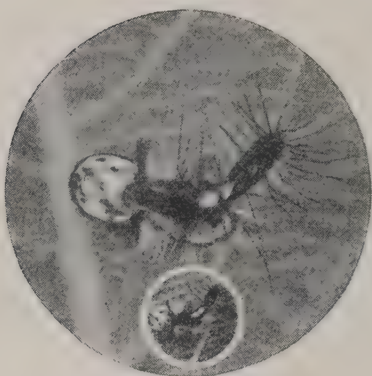


Fig. 216. Cocoon of Ichneumon parasite and skin of victim (Vapourer caterpillar). Magnified ($\times 3$) and natural size.

Fig. 217. Caterpillar of large white butterfly with maggots of Ichneumon just emerging and spinning cocoons. Inset, Ichneumon fly.

In the previous year all the caterpillars examined of a common species of butterfly attacking the cabbage (the *large white butterfly*) were found to be "parasitised" by an Ichneumon fly, not a single healthy one being discovered (see fig. 217). In consequence, the cabbages were, in the present season, practically free from this pest.

Beneficial insects which attack insect pests may be divided into two classes:

1. Those which devour their victims;
2. Those which pass their early stages inside the bodies of their victims, or *parasitise* them.

[1] As regards the propagation and use of beneficial insects for combating various pests, see Appendix IX, page 708.

Caterpillars

There are several caterpillars which are "cannibals" and prefer to devour others of their own class than to live upon vegetation. Chief in importance of these to the fruit grower is the **Dunbar**, which is often found upon apples and other fruit trees. This caterpillar, which

Fig. 218. Ichneumon maggot just emerged from parasitised Dunbar caterpillar, and about to pupate. Also a specimen which has pupated.

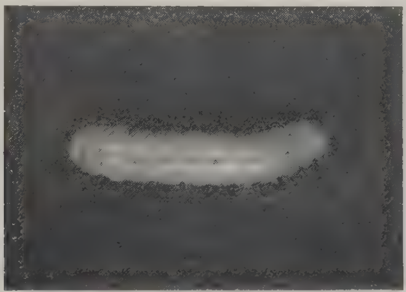


Fig. 219. Dunbar caterpillar. Natural size.

resembles somewhat that of the Winter Moth, being of a light green colour, will devour many destructive caterpillars before it is mature. This caterpillar is also commonly parasitised by an Ichneumon fly, and in this case, since the caterpillar is beneficial, the Ichneumon must be looked upon as an enemy! (see fig. 218). No caterpillars are known to be parasitic in the bodies of other insects.

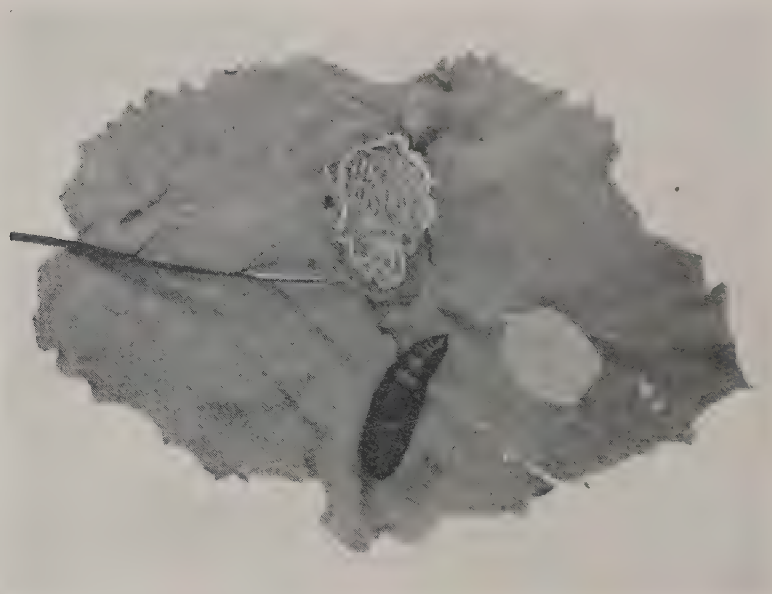


Fig. 220. Dunbar pupa. Natural size.

Fig. 221. Dunbar moths. Natural size.

Beetles

The most important beneficial beetle is the well-known **lady-bird** beetle. Both the adult and its larva or "nigger"—particularly the latter –live upon aphis, and especially upon the hop aphis. The yellow eggs, in regular groups, resembling skittles, are familiar objects on the leaves of the hop (see fig. 222). The "nigger" is a small, black, active grub with long legs, and yellow spots on the body, and the pupæ are formed on the leaf, are quite inactive and have a shield-like appearance. The lady-bird undoubtedly does an immense amount of good and is apparently frequently the means of clearing off an attack upon the hop—at any rate it is often found in large numbers just before the aphis disappears.

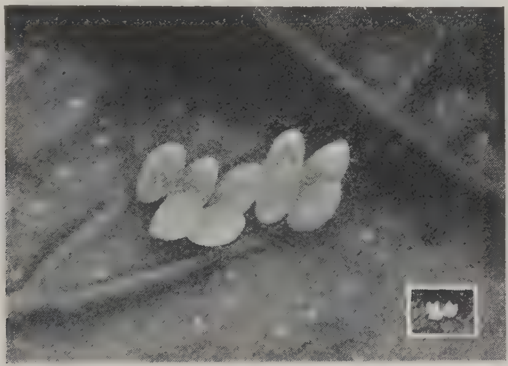


Fig. 222. Eggs of Lady-bird on hop leaf. Magnified (× 6) and natural size.

There are two other insects, the larvæ (maggots) of which feed upon aphides. These both belong to the two-winged fly family (*Diptera*). The first is the so-called **Wasp-fly** which belongs to the group called HOVER-FLIES, on account of their habit of hovering over the flowers of plants. The Wasp-fly is very conspicuously banded with black and yellow and is commonly mistaken for a wasp, but is quite unlike it in other respects. The larva (maggot) is a curious greyish slimy-looking creature, often found upon fruit leaves, and feeding upon various species of aphis (see fig. 224).

The other beneficial insect of this class which devours other insects is the **Lace-winged fly**[1], the larva of which is frequently found upon hop leaves and is called the **aphis lion** on account of its feeding upon aphis, and its voracious habits (fig. 226).

[1] See illustration of adult insect on page 711.

This is a curious and interesting insect, especially in the manner of laying its eggs, which are placed upon stalks formed by a secretion of the insect's body. The fly first places its tail end on the leaf and then elevates it, exuding the sticky thread which at once hardens. The egg is then laid on the top of the

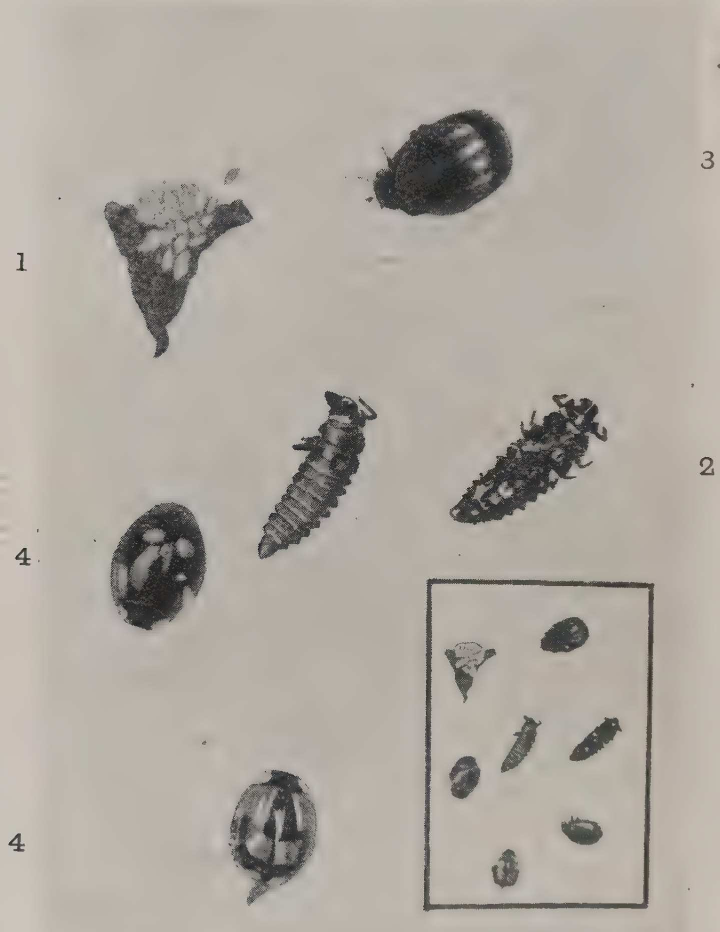


Fig. 223. Various stages of Lady-bird beetle. 1, Eggs. 2, grub. 3, pupa. 4, adult (two varieties). Enlarged (× 3) and natural sizes.

stalk so formed. This procedure is to protect the egg by placing it out of the reach of insects which would devour it. On hatching the young larva crawls down the stalk on to the leaf (see fig. 226).

In the second group, viz. those insects which pass part of their life as parasites in the bodies of others, by far the most important are

the **Ichneumon flies**. These form a well-marked group of four-winged flies (*Hymenoptera*[1]). They have mostly slender wasp-like bodies, and long legs and feelers, and gauzy wings. By means of a long and slender tube at the end of the body (the *ovipositor*) they pierce the skin of caterpillars and other insects, and insert their eggs within the body. They attack almost every species of insect known, either in its larval or pupal stage. Thus fig. 227 shows aphides on nettles parasitised by an ichneumon fly. The eggs, of which there may

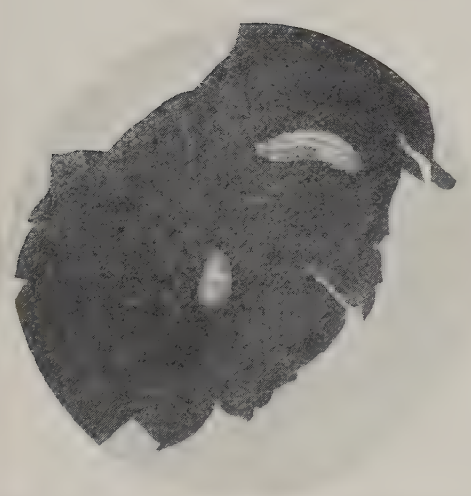


Fig. 224. Wasp-fly maggot and pupa on hop leaf. Natural size.

Fig. 225. Wasp-fly. Magnified (× 3) and natural size.

be a great number, hatch in the body of the victim, and the footless maggots live and grow upon its vital juices. Great care is however taken not to attack any vital organs so that the host is not killed until it is mature. When this happens, a hole is bored from the interior in the insect's skin, and the maggots emerge, spinning silky cocoons near by the dead body of their victim, which soon shrivels up (see figs. 217, 229). In many cases, the pupa is attacked and is finally killed in the same way (see fig. 228).

Another class of insects, very similar to the Ichneumons in their

[1] See page 233.

habits (and often referred to as *Pseudo-ichneumons*) belong to the two-winged flies (*Diptera*[1]). These are known as **Tachina flies**. They closely resemble the common bluebottle in appearance. They lay their eggs in the bodies of other insects, especially caterpillars, just as do the Ichneumons (see figs. 230—232).

The **Chalcid flies** are another important group. These are small, two-winged flies which puncture the bodies of their victims in

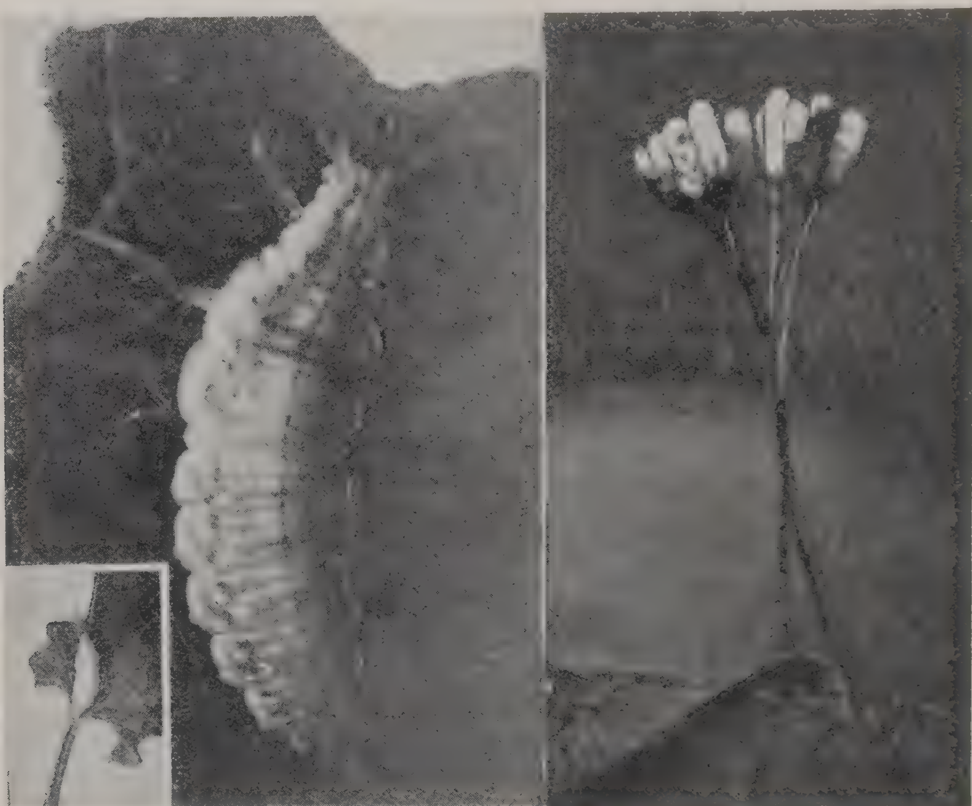


Fig. 226. Larva of Lace-winged fly ("aphis lion") magnified (× 7). Inset, natural size. Also eggs of same, showing cluster on stalks. Highly magnified.

a similar manner to the two preceding groups. They may be told by their bodies, which are commonly of a brilliant metallic tint. Some of them are very minute, and their larvæ (maggots) live, not in the larvæ, but in the eggs of other insects. Still smaller flies are known as parasites which infest, not only insect pests, but Chalcid and Ichneumon flies. To this extent they are not "beneficial" but destructive, since they prey upon insects which are friendly to the grower.

[1] See page 234.

Fig. 227. Parasitised nettle aphides (dead). Inset, healthy aphis and Ichneumon fly. Magnified (× 3) and natural size.

Fig. 228. Parasitised pupæ of large White Butterfly, showing maggots emerging from pupa case, cocoons of parasite, healthy pupa and Ichneumon fly. Magnified ($\times 2\frac{1}{2}$) and natural size.

Fig. 229. Ichneumon flies and their cocoons, showing also shrivelled skin of parasitised caterpillar. Magnified (× 3) and natural size.

Fig. 230. Tachina fly infesting caterpillars. Magnified (× 3) and natural size.

Fig. 231. Pupa of Tachina fly, showing also old skin of caterpillar (Gold-tail Moth). Magnified (× 3) and natural size.

Fig. 232. Tachina fly and pupa case. Parasitic on Tortrix caterpillars. Magnified (× 3) and natural size.

PART II

FUNGUS DISEASES OF FRUIT AND THEIR CONTROL

SECTION VII

FUNGUS DISEASES

SECTION VII

FUNGUS DISEASES

CHAPTER 28

About Fungi

In addition to insect pests the fruit grower has a large number of fungus diseases to contend with. Some of these are very serious and extremely difficult to control, and almost all cause serious losses in the fruit crop (see Chapter 1).

Fungi belong to a low division of plant life, and differ from the higher plants in having no flowers and in producing no green colouring matter (chlorophyll).

A great many fungi are quite harmless to plants, growing upon decaying animal or vegetable matter. Others are unable to grow except upon the living tissues of plants, and are thus always *parasitic* in habit. Many, again, are sometimes parasitic and at other times not so.

Although fungi do not produce flowers, they bear "fruit" and "seed" of a special kind, called SPORES, which, under suitable conditions, are able to germinate and produce fresh growths of the fungus. Spores may be of two kinds, known as SUMMER and WINTER (or scientifically *conidial* and *perithecial*), which will be referred to again later.

The body of the fungus is made up of long, very fine threads, or filaments (called *hyphæ*). These usually form an interlacing, mat-like tissue, called the spawn, or *mycelium*. It is this mycelium which is responsible for the damage to fruit trees, since the tissues of the plant are broken down and finally killed, after supporting the fungus by means of the sap from the cells of which they are composed.

The threads and the spores of the fungi which attack fruit are much too minute to be distinguished with the naked eye. It is only therefore by the aid of a powerful microscope that their structure can be investigated, and in describing the various forms of fungus disease an account is given of the general appearances of the fungus growths as seen by the unaided sight, or with the help of a small hand-glass. By this means, and by the effects produced upon the diseased parts of the plant, it is

usually possible readily to identify the particular disease in question. In a few cases little or no sign of the fungus itself is to be seen at the time when it is most harmful (e.g. in the Apple Blossom Wilt Disease, page 494). In such instances the disease must be identified by the *symptoms* it produces, such as the wilting and death of the blossom in the instance given.

For the sake of completeness, a summary is given of the microscopical characteristics of the various fungus diseases described in this section of the book. This is placed in small type at the end of each account and may be neglected by the grower.

In the interests of students, a brief statement may be given of the scientific aspect of the subject.

The Mycelium

The hyphæ consist of transparent tubes, the walls of which usually contain more or less *chitin*, cellulose being generally absent.

These tubes are more or less filled with a colourless *cytoplasm*; and minute globules of oil may be present, but no starch grains, as in higher plants. In the higher fungi the hyphæ are divided into larger or shorter cells by partitions, or *septa*, and are spoken of as *septate*; but lower forms are not thus divided, the tube of the filaments being continuous.

The hyphæ usually branch freely, and the tip of each branch grows continuously, and in this manner an interlacing *mycelium* is produced. The interweaving of the hyphæ in the mycelium is often so close that a flat sheet of delicate threads is produced, resembling felt or, in some cases, tough leather. In other cases, notably in the higher fungi, the mycelium becomes hardened and dark in colour, forming compact masses of varying shape. Growth then ceases, and in this form, termed in the plural *sclerotia*, the fungus is able to remain dormant throughout the winter season, becoming active in the following spring or summer.

The mycelium is usually embedded in the plant tissue, but it may be entirely outside, as in the case of the POWDERY MILDEWS, and in such cases, branches, termed *haustoria*, are sent into the tissues of the leaf or stem which form suckers or roots to supply the fungus with nutriment. In such cases it is obvious that the fungus is more open to treatment and control by chemical agents than when it is enveloped by the plant cells themselves.

The Spores

The spore-bearing portions of the fungi answer to the reproductive organs of the higher plants. Each spore consists of a single cell, produced and

set free by the parent plant, and capable of giving rise to a new growth of the same kind.

Great variations exist in the size, shape and character of the spores, and of the method in which they are produced. Spores are commonly spherical or oval in shape, but they may be spindle-shaped, oblong, club-shaped or long and slender.

Spores may also be produced by a sexual process, termed "sexually-produced spores," or without, termed "asexual." The latter are by far the commonest, and sexually-produced spores are only found in the lower forms, if we except the *Ascomycetes* (which is a debatable point).

Sexually-produced spores may be of two kinds, termed *zygospores* and *oospores*.

The asexually-produced spores are also divided as follows:

1. Endospores.
2. Conidia.
3. Oidia.

Endospores are produced within a *sporangium*, or spore case, by a division of the protoplasm. The sporangium is carried on a *sporangiophore*, by means of which it is attached to the mycelium. Some endospores are naked and are able to swim freely about by means of movable hairs (or *cilia*), and others have a definite cell-wall.

The ASCUS, which is a modified sporangium, contains a limited number of *ascospores* and is characteristic of a large class of fungi, many of which are important parasites, giving rise to plant diseases.

Conidia are very simple spores, borne naked upon the top of a branch hypha termed a *conidiophore*. They are single cells produced by a partition in the top of the latter, and then set free. They are of very varied sizes and shapes. A special variety of conidiophore, termed a *basidium*, is characteristic of another large group of fungi, the *Basidiomycetes*.

Oidia are spores formed by the mycelium becoming divided into a number of short segments, which may remain united in chains or become free from each other. They often, on germination, produce short hyphæ, bearing conidia or sporangia.

Many fungi produce more than one variety of spore at different times from the same mycelium. Thus the members of the important family of the ASCOMYCETES produce both conidia ("summer spores") and ascospores (a form of endospore), or so-called winter spores.

The discovery of different kinds of spores produced by the same fungus has led to great confusion in the classification, and many of the fungi as now known are undoubtedly capable of existing in other forms than those at present described.

Germination

Some spores, usually the endospores and conidia, germinate in a few hours in the presence of moisture and a suitable temperature. Others, termed *resting spores*, require a certain lapse of time before they will germinate.

On germination, a delicate *germ-tube* is emitted by the spore, which, in the presence of appropriate nutriment, produces hyphæ and grows into a mycelium. Spores often possess a double cell-wall, and in this case the outer wall is punctured and the inner wall is prolonged into the wall of the hypha.

Fungus spores are disseminated by wind, air currents, flies, bees and other insects, and snails.

Thus areas widely separated from infected trees may become diseased by means of these agencies.

The disease is **carried over** from season to season on the same plant in different ways. Often there is a winter fruit of the fungus producing *winter spores* which infest the young leaves or flowers the following spring or summer.

This fruit may be produced on the branches or on leaves or fruit which have remained on the tree throughout the winter.

In other cases, portions of the mycelium (spawn) winter in the tissues of the branches, or in the young buds and become active again in the following year.

Plants are **infected** with fungus disease by means of spores which are carried to the plant by various agencies. One of the most curious and important features of fungus attack is that plants are only capable of infection by certain kinds of spores. Thus, the spores of gooseberry mildew falling upon an apple leaf are incapable of germinating and so causing infection on the apple. This is considered to be due to various different chemical substances which exist in the cells of all plants, and which are capable of attracting certain fungus spores only to the exclusion of others. In the case of the *powdery mildews*[1] this feature is carried to greater lengths, different "strains" of what is apparently the same species of fungus being capable of growing on certain plants only, and incapable of infecting others. It must not therefore be thought that a fungus producing say leaf spot on apples will be a source of danger to cherries, or that, because the strawberries are badly mildewed, there is danger of infecting a crop of gooseberries near by.

[1] As Professor Salmon has shown.

CHAPTER 29

Causes and Prevention of Fungus Diseases

As to the **causes** of fungus attacks this is still to some extent an unsettled question. It is quite certain that the STATE OF THE WEATHER has a great deal to do with liability of a plant to fungus attack. The conditions favourable to fungus attack may be summarised as:

1. Absence of direct sunshine.
2. Cold in late spring and summer.
3. Excessive moisture due to lack of air currents.

Such conditions are usually obtained in "close" and "stuffy" weather, and experienced growers have an instinctive knowledge when to expect fungus attacks by observing the weather conditions. Our forefathers believed that disease was caused directly by unfavourable weather, and although we now know that it is only a secondary cause, providing conditions suitable for the growth of the fungus, it is nevertheless a fact that in bright sunny weather infection with fungus diseases is rare, and even badly infected plants are able to resist the attack.

Weather conditions are however by no means the only predisposing causes of fungus attack, or even the most important. Thus many fungi, especially those attacking fruit, are unable to gain an entrance to the plant except through **wounds**, and are thus termed *wound-fungi*. Wounds may be caused by many agencies, but the three commonest are:

1. Insect punctures.
2. Wind.
3. Hail.

Since the fungus spores are extremely minute, it is evident that the tiniest rupture of the surface of the skin of a plant is sufficient to admit the disease. Insects, especially aphis, are undoubtedly the most usual instruments of infection. Thus we know that the *canker fungus* invariably follows upon attacks of woolly aphis, and no doubt there are numbers of instances of the same kind. Wind and hail cause bruises

and rupture of the skin, especially of fruit and leaves, and so lay the plant open to the entrance of fungus spores.

The foregoing are natural causes which, except to some extent in the case of insect attacks, cannot be prevented by growers. In addition to these, however, there are many **preventable causes** of fungus attack. Of these the most important is BAD CULTIVATION, resulting in:

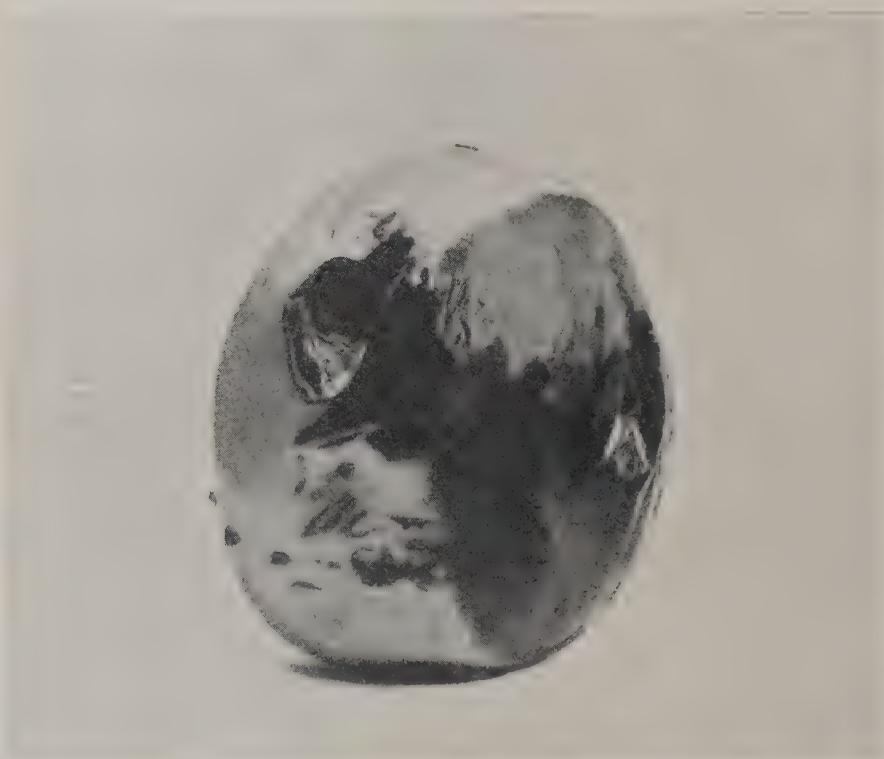


Fig. 233. Typical injury caused to apple by hail. Natural size.

1. An insufficiency of air supply to the roots of the plant.
2. Inadequate drainage, causing a water-logged condition of the soil.
3. Insufficient protection against extremes of heat and cold.

Further, a very common preventable cause of fungus infection is neglect to remove fallen and rotten fruit and leaves, on which the fungus bears fresh crops of spores in the winter, or leaving the diseased fruit or dead and decayed leaves and branches on the tree to carry on the attack from one season to another. A very great deal may thus

be accomplished by clean and careful cultivation, general hygienic methods, and attention to the trees during the dormant season.

The neglect to adequately protect **cut and exposed surfaces** of trees after pruning or injury is responsible for much fungus infection. In such cases the wounds should be carefully coated over with tar, shellac varnish, or wax (the first named is the safest), so as to give the spores no loophole to effect an entrance.

Fungus diseases will never adequately be dealt with until united and simultaneous action is ensured by all growers, of whatever size their orchards may be. In order to secure this, it is practically essential that the Government have compulsory powers in regard to spraying and treating diseased plantations. Otherwise, as previously pointed out (page 7), an enlightened and painstaking grower will always be open to attack from the neglected orchards of his neighbour.

In addition, there is the question of wild varieties of fruit, which may serve as breeding grounds for the fungus. Although much may be accomplished by united action, it is on the whole improbable that diseases can ever be completely stamped out. It is specially necessary to keep a rigid watch on imported stock, and in suspected cases to keep stock in quarantine until examination has been made.

Authorities

Our present knowledge of fungus diseases is, as in the case of insect pests, the accumulation of the work of many observers. It is somewhat invidious to select from the names of so many eminent mycologists, but it might be mentioned that in recent years we are indebted to Professor Salmon and Dr Wormald of Wye for special light on the powdery mildews and on fruit rot respectively.

The following is a short list of some past and present workers in this field:

Aderhold	Duggar	Pole-Evans	Stoneman
Bailey	Eriksson	Schrenk	Wiltshire
Barker	Gimingham	Scott	Ward
Brooke	Goethe	Smolak	Wormald
Cooke	Hartig	Somerville	Woronin
Cotton	Massee	Southworth	
De Bary	Percival	Spaulding	

DISEASES OF THE APPLE

PLATE XIII

494 Apple Blossom Wilt (*a*) on blossom, (*b*) on branch
501 Apple Canker 505 Apple Leaf Spot
507 Apple Mildew 510 Apple Scab

chromo-lith Cambridge University Press

PLATE XIV

491 Apple Bitter Rot (*a*) early stage, (*b*) later stage
497 Apple Brown Rot (*a*) early stage, (*b*) later stage

chromo-lith Cambridge University Press

CHAPTER 30

Diseases of the Apple

APPLE BITTER ROT

Name *Glomerella rufo-maculans* Order *Ascomycetes*

Plants Attacked

Apples: less commonly pears, peaches, grapes.

Related Diseases

Apple scab, pear scab, apple canker, etc.

1. General

This is a very serious disease, and occurs in practically every country where the apple is cultivated. It is estimated that in America the loss of fruit occasioned runs into millions of dollars annually. The fruit and the branches are both affected, but the damage to the latter often passes unnoticed.

Occurrence and Symptoms

This first appears under the skin of the apple as a small, brown spot, but there may be two or more visible at the same time on the fruit. The spots usually increase rapidly in size, being more or less round, and having a definite outline.

The affected part next sinks in, the diseased area increases, and small circles of black points appear, one within the other. This is the fruit of the fungus, and pinkish sticky masses of spores (conidia) soon appear, which may be washed off by rain.

This fungus is often associated with a canker disease on the young branches. This appears as burnt-looking, cracked patches on the bark, parts of which may break away leaving open wounds. On these patches, summer (conidial) fruit is developed, the spores from which become mature earlier in the year, and infect the young apples by falling upon them.

It has been found however that this canker stage (Glœosporium) is not necessary to carry on the fungus from year to year, as the spores on the fruit will retain their vitality over the winter.

Effect on Plant

The diseased apples often drop off the tree, becoming prematurely ripe, but in certain cases of very rapid development they may hang on the branches in a "mummified" condition till the following year. The diseased part of the flesh of an attacked apple has a very bitter flavour.

How infection occurs

1. By the spores of the ascigerous ("winter") fruit upon the diseased apples falling from the cankered branches of mummified fruits.
2. From the conidial (summer) spores, which may also be carried by insects from other trees.

   The spores appear to be able to cause infection in apples with perfectly whole skins, the germ-tube penetrating the stomata (breathing pores).

Conditions favourable to Fungus

Close, warm, wet weather. Cool, dry, summer weather is a definite check to the disease.

Frequency of Disease

Common.

Distribution

World-wide.

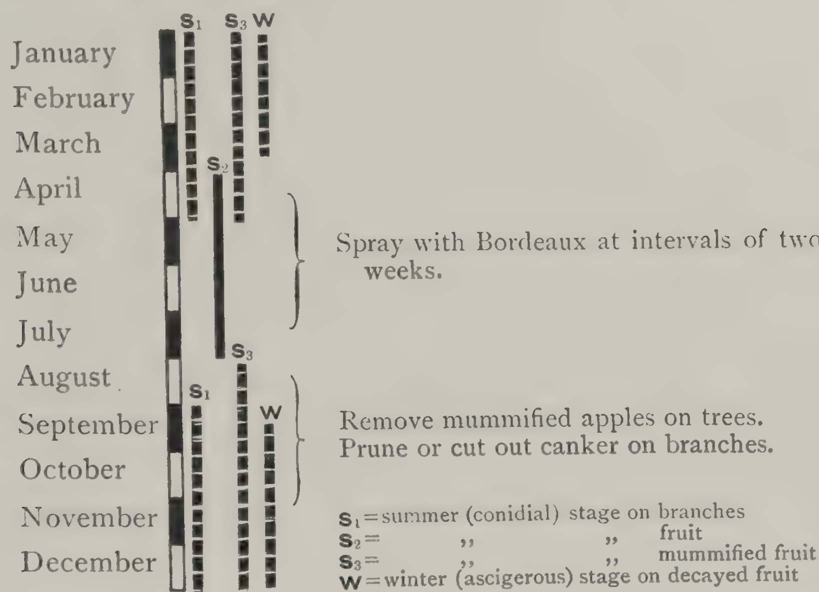
Treatment (Control)

1. Remove and destroy all diseased fruit, both that which has fallen and any "mummified" apples hanging on the branches.
2. Prune off any cankered shoots down below the limit of the diseased portion, and burn these. In the case of the larger branches cut out the cankered areas, and dress with TAR[1].
3. Spray with BORDEAUX MIXTURE[2].
   (1) before buds burst.
   (2) 5 weeks after.
   (3) at intervals of two weeks after, till fruit is ripe.

In case of cool and dry weather, less sprayings will suffice.

[1] See page 417. [2] See page 604.

Calendar of Treatment



2. Scientific

A. Conidial Stage

Appearance.	As brown patches, with concentric rings of fructifications.
Location.	Under skin of fruit and in canker spots on branches.
Appears in	May or later.
Duration.	Often throughout winter on fallen or mummified apples.
Mycelium.	Throughout discoloured portions of the apple, and in the cambium of the branches.
Conidiophores.	Erect on stromatic mass of mycelium.
Conidia.	Embedded in a gelatinous matrix, readily soluble in water.
Appearance.	Oblong to ovate hyaline.
Size.	$\cdot 12$—16×4—6μ.

B. Ascigerous Stage

Appearance.	Greenish masses.
Location.	On decayed apples.
Appears	At variable times.

DURATION.	The canker spots probably last two years.
MYCELIUM.	Dark olive green.
PERITHECIA.	
Appearance.	Subglobose.
Location.	Buried in decayed flesh of apple.
ASCI.	Oblong-clavate: $55—70 \times 9\mu$.
ASCOSPORES.	8: resemble conidia: curved $12—22 \times 3\frac{1}{2} - 5\mu$.

APPLE BLOSSOM WILT[1]

Name *Monilia cinerea* Class *Helotiaceæ*
Order *Discomycetes, Ascomycetes*

This disease is really a form of the BROWN ROT fungus, but usually attacks and kills the flowers, being rarely seen on the fruit.

Plants Attacked

Apple.

Related Diseases

Common Brown Rot (*Sclerotinia fructigena*), "wither-tip" of Plums (page 578).

1. General

In recent years this disease has become very common, particularly in certain varieties of apples, and especially *Lord Derby*. It has probably escaped notice in the past, because it is very likely that the damage caused by it was attributed to frost.

Although the fungus produces a "brown rot" on the fruit, it does not usually appear in this manner, but is known by the death of the flowers in spring and the subsequent appearance of a canker on the branch, producing pustules of the fungus the following spring, spores from which infect and kill the blossom.

Occurrence and Symptoms

The first symptom of the disease occurs in the spring (about May) when the leaves and flowers in a blossom truss commence to flag, and then wilt and finally die. In the distance the leaves look greyish owing to the tendency to curl inward and expose the under-surfaces.

[1] See Wormald, *Annals of Applied Biology*, Vol. III. 4, 1917, 159—204.

After the death of the flowers, the fungus grows along the branch and produces a canker, and, in the following year, grey pustules of the fungus are produced at this spot and infect the flowers. The growth of the fungus then ceases at this place, and the injured surface becomes healed over. The pustules occur only rarely on the fruit.

Distinguishing Features

Infection takes place THROUGH THE OPEN FLOWERS ONLY, the fruit is rarely attacked.

Effect on Plant

Up to 75 per cent. of the blossom is often killed on the trees, and the effect is thus very serious, trees badly attacked yielding no fruit at all year after year.

How infection occurs

By the conidia (summer spores) falling from the pustules of the fungus on the old branches on to the open flowers.

Susceptible Varieties

Lord Derby very susceptible, also Cox's Orange Pippin, Allington, Worcester, James Greve, Ecklinville, etc.

Charles Ross, Bramley, Blenheim, and Beauty of Bath appear more resistant.

Frequency of Disease

Common in recent years.

Distribution

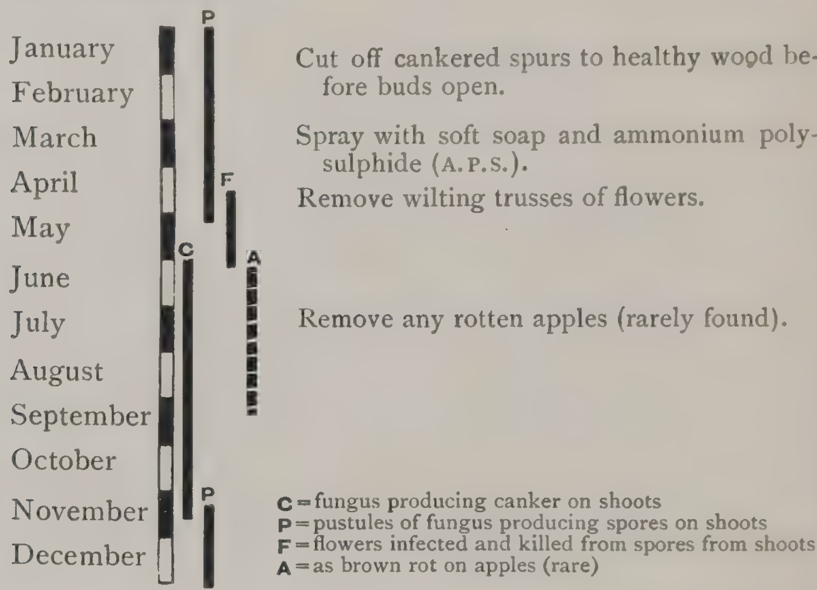
Noticed chiefly in Kent and Sussex, and probably occurs widespread on the continent.

Treatment (Control)

1. Wherever practicable, remove in spring all trusses showing signs of wilting before the fungus has had time to penetrate into the branch. By this means, canker of the small branches is prevented.
2. Remove all cankered spurs and branches before the flowers open in spring, cutting back to the healthy wood.
3. Growers are advised to try spraying in spring, just before the blossoming of the tree (as No. 2, fig. 244 on page 616), with SOFT

SOAP[1] and AMMONIUM POLYSULPHIDE[2] ("A.P.S." wash). Lime-sulphur does not sufficiently wet the fungus to be of certain benefit.

Calendar of Treatment



2. Scientific

A. Conidial Stage

APPEARANCE.	*Grey* pustules.
LOCATION.	On cankered shoots only.
APPEARS IN	Winter and spring.
DURATION.	One season.
MYCELIUM.	White, in shoot.
CONIDIA.	In general, smaller than the brown-rot conidia (*fructigena*).
Appearance.	Hyaline, ovoid.
Arrangement.	Simple or branched chains: $10—14 \times 7—9{\cdot}5\mu$.

B. Ascigerous Stage

Not yet discovered.

[1] See page 452. [2] See page 600.

APPLE BROWN ROT

Name *Sclerotinia fructigena* Class *Helotiaceæ*

Order { *Discomycetes* / *Ascomycetes* }

Plants Attacked

Apples, plums, cherries, peaches, apricots, etc.

Related Diseases

Monilia cinerea, gooseberry collar rot.

1. General

The disease termed BROWN ROT is a very general and very destructive fungus, and affects almost all "top fruits." As far as is at present known only the fruit is attacked.

The attack of the allied "*Blossom Wilt*" disease (*Monilia cinerea*) is very similar on the fruit, but in this fungus the flowers are usually killed before the fruit forms.

In the case of the other fruits attacked, the appearance of the disease is very similar, except that the pustules are not arranged in rings or circles as in the case of the apple.

This disease was formerly known as *Monilia fructigena*, this being the conidial stage, and the only one known in this country. Recently the ascigerous stage has been described, and the fungus is found to be the summer stage of the *sclerotinia*.

Occurrence and Symptoms

The apples are attacked during the summer or early autumn. Small brown discolorations appear which rapidly increase in size and finally involve the whole fruit. Small pimply swellings meanwhile occur under the skin which soon burst through, appearing usually as rings of yellowish pustules with a powdery surface; these ripen and produce spores which spread the disease to neighbouring trees. The attacked fruit rapidly shrinks in size and deep grooves and wrinkles appear on the

Fig. 234. Apple affected with brown-rot fungus; showing also commencement of rot (caused by contact) on a neighbouring healthy apple. Slightly reduced.

skin. Apples may fall or may hang on the trees in a mummified condition throughout the winter. The mycelium or spawn of the fungus ramifies throughout the entire fruit. On fallen apples, fresh pustules of the disease appear, and on the mummified fruits a new crop of spores are produced in the following summer, which infect the young fruit.

The disease also occurs on *stored fruit* after it is picked and may spread amongst many apples if these are packed together. Stored fruit should therefore be periodically examined and any showing signs of disease removed and destroyed.

In certain varieties of apples the fruiting spur is also attacked, a canker is produced round the base, and pustules of the disease appear in the following spring.

The canker is very similar to that produced by the *Blossom Wilt* fungus, but in this case infection takes place through the *flower* only, while in the case of Brown Rot it is the *fruit* and only the fruit which is the channel of infection.

Distinguishing Features

Distinguished from the allied *Blossom Wilt* (*Monilia cinerea*) by the lack of infection of the flower, which the former usually kills.

Effect on Plant

The apples attacked become withered, dry and "*mummified*," and either fall off the trees or remain in this condition throughout the winter.

Degree of Damage

Always serious, and frequently ruining the crop.

How infection occurs

The spores (conidia) are produced in great numbers from the rings of yellowish pustules on the attacked fruit. The spore probably gains an entrance to the healthy fruit through some slight cut, bruise, or incision caused by wind or insect agency

Frequency of Disease

Common.

Distribution

Widespread.

Treatment (Control)

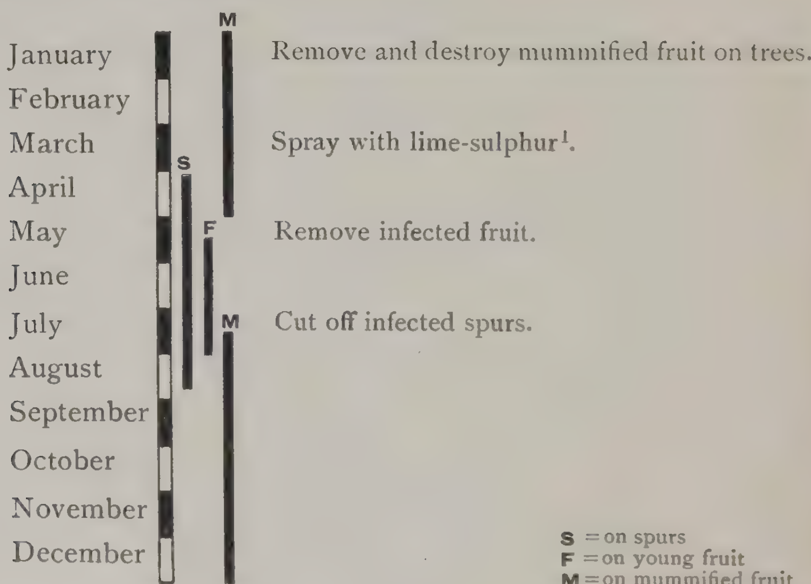
Since the *mummified* fruit hanging on the trees is a source of fresh infection the following year, it should always be *entirely removed and destroyed.*

Apples which show any signs of the disease should be plucked off in their early stage, where this is possible.

Cut off also any infected or cankered spurs, either in the summer (best time) or during the winter months.

Spray with strong LIME-SULPHUR[1] before the buds burst in the spring.

Calendar of Treatment



[1] See page 612.

2. Scientific

A. Conidial Stage

APPEARANCE.	In yellowish powdery tufts, forming concentric circles (in apple).
LOCATION.	On fruit and on spurs.
APPEARS IN	Summer and throughout winter, on decayed fruit.
MYCELIUM.	Ramifies throughout fruit.
CONIDIA.	
Appearance.	Hyaline, ovoid.
Arrangement.	Simple or branched chains $21—25 \times 10—12\mu$.

B. Ascigerous Stage

Not known in England.

APPLE CANKER

Name *Nectria ditissima* Class *Hypocreaceæ*
Order *Ascomycetes*

Plants Attacked

Apples, pears, gooseberries.

Related Diseases

Apple bitter rot (*Glomerella rufo-maculans*).

1. General

This fungus is very common, especially on apple trees and in neglected orchards. It cannot attack healthy bark, but obtains an entrance through wounds, especially those caused by the WOOLLY APHIS. In fact, attacks by this insect are almost invariably followed by the canker. The fungus does not die at the end of a season, but goes on increasing till death of the branch results, and, on the trunk, large cankers are produced.

Occurrence and Symptoms

The first sign of the fungus is the cracking of the bark, which usually splits into regular semi-circular grooves. These isolated segments die and drop off.

Fig. 235. Two branches of apple badly attacked by canker fungus.

Later the wood is also attacked, and small branches are completely girdled and the branch destroyed.

More usually, an oval-shaped or irregular callus is formed round the wound.

Two kinds of spores are produced, the first (conidia) being liberated from the fruit, which occurs during the autumn as white pustules. What is generally termed the winter fruit (ascigerous stage) is produced in spring, appearing as dark red clusters on the edges of the wound. From these, the "winter spores" (ascospores) are liberated.

Effect on Plant

The yield of fruit is undoubtedly diminished by canker attack, as the vitality of the tree is necessarily weakened. The effect of the canker is cumulative, increasing each year, and finally resulting in the death of the tree.

Degree of Damage

In spite of the above, many badly cankered trees continue to yield fair crops of fruit, but they form centres of infection for the other healthy trees.

How infection occurs

The fungus spores gain an entrance through wounds of every kind, especially those caused by the punctures of the woolly aphis.

Frequency of Disease

Common, especially in neglected orchards.

Distribution

Widespread in Europe : less known in America.

Prevention

Insect attacks should be kept in check, especially that of the WOOLLY APHIS[1].

An annual treatment of the bark by spraying with the stronger LIME-SULPHUR[2] in the winter, or early spring, will keep it in a healthy condition and make it more resistant to attack.

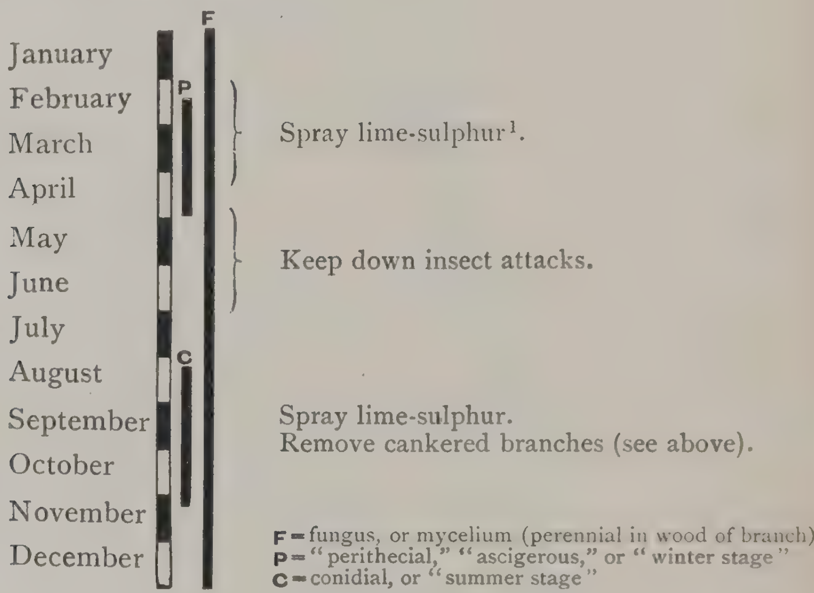
Remedies

1. Remove and burn all badly cankered branches.
2. Cut out cankers where these are slight, or dress wounds with gas-tar, or other protectant[3].

[1] See page 327. [2] See page 612. [3] See page 417.

3. Cut down all trees which are badly attacked, as these form dangerous centres of infection.
4. Spray annually in the winter and spring with winter-strength LIME-SULPHUR[1]. (Spraying is useless unless accompanied by measures 1 and 2.)
5. Cut back the tree and top graft with less susceptible variety such as *Bramley Seedling*.

Calendar of Treatment[2]



2. Scientific

A. Conidial Stage

APPEARANCE.	White pustules.
LOCATION.	On cankered areas.
APPEARS IN	Summer.
DURATION.	Few months.
MYCELIUM.	Perennial in the wood of branches.
CONIDIA.	
Appearance.	White; fusiform.
Arrangement.	3—5-septate; 35—60 × 4·5—5μ.

[1] See page 612.

[2] The canker fungus is perennial (occurs year after year).

B. Ascigerous Stage.

Appearance.	As small dark red clusters.
Location.	On margins of cankered areas.
Appears in	Autumn and winter.
Duration.	2 to 3 months.
Perithecia.	
Appearance.	Blood-red ; in dense clusters.
Asci.	Cylindrical, 8-spored.
Ascospores.	Ovate-oblong, hyaline, 1 septate, $6—8 \times 3—4\mu$.

APPLE LEAF SPOT

Name *Sphæropsis malorum* Class *Sphæroidæ*
Order *Deuteromycetes*

Plants Attacked

Apples.

Related Diseases

Gooseberry shoot spot, pear leaf spot, strawberry leaf blight, currant leaf spot.

1. General

Occurrence and Symptoms

In the spring, reddish-brown spots appear upon the apple leaves, of variable size and shape. Occasionally these have a purple margin, and later the spots have a greyish appearance. The disease continues developing and involving fresh leaves throughout the summer.

The patches show the limit of the fungus mycelium, and the minute black points on the diseased patches are the pores or openings through which the conidia (spores) escape.

Effect on Plant

The leaves droop and fall, and if the disease continues unchecked the tree is seriously weakened, and the fruit suffers in yield and quality.

How infection occurs

By means of the conidia (summer spores) scattered by wind and insect agency, etc.

Conditions favourable to Fungus

Damp, muggy weather.

Frequency of Pest

Not common.

Distribution

Widespread—especially noted in America.

Remarks

This fungus produces a rot in the apple and a canker on the bark of the tree in America[1].

Treatment

Spray the trees with BORDEAUX MIXTURE, summer strength (see page 609), 2 to 3 weeks after the blossom has fallen, and follow by a further spray about one month later.

Calendar of Treatment

Month	Stage	Treatment
January		
February		
March	s	
April		
May		Spray with summer strength Bordeaux.
June		Apply again.
July		
August		
September		
October		
November		Winter stage unknown.
December		

s = summer or conidial stage

2. Scientific

A. Conidial Stage

APPEARANCE.	Reddish brown spot, coalescing.
LOCATION.	On leaves.
APPEARS IN	Spring.

[1] Puddock Wendell. *New York Agr. Exp. Stn. Bull.* 163. 331–369 : 185, 205–213.

DURATION.	Throughout season.
MYCELIUM.	Embedded in leaf tissue.
CONIDIA.	Contained in a perithecium, $25 \times 10\mu$.
Appearance.	Oblong, coloured.

B. Ascigerous Stage

Not yet known.

APPLE MILDEW

Name *Podosphæra* Class *Erysiphaceæ* (*Powdery mildews*)
Order *Ascomycetes*

Plants Attacked

Apples.

Related Diseases

Other powdery mildews on gooseberry, hop, etc.

1. General

This disease resembles most of the other "powdery mildews." They have, in their summer (conidial) condition, a powdery, floury appearance, and the spawn or mycelium of the fungus is entirely on the outside of the plant, the fungus obtaining its nourishment by means of suckers or *haustoria* which bore into the leaves through the cell-wall.

On this account they are easier to deal with in their summer stage than those fungi which have their mycelium entirely embedded in the plant tissue.

Occurrence and Symptoms

The ends of the twigs show the first signs of the disease, and have the appearance of having been sprinkled with flour. This is the summer (conidial) stage of the fungus.

It is probable that a portion of the mycelium (spawn) of the mildew remains between the leaves of the bud throughout the winter and that this gives rise to the disease again in the following spring.

The winter (ascigerous) stage is comparatively rare, but has occasionally been found.

Distinguishing Features

Its white, floury appearance on the tips of the twigs.

Effect on Plant

The shoot is prevented from growing, owing to the exhaustion produced by the fungus it becomes stunted and in bad cases withered.

How infection occurs

1. From the summer (conidial) spores.
2. From portions of mycelium (spawn) wintering in the buds.
3. From the winter (ascigerous) spores—more rarely.

Susceptible Varieties

Lane's Prince Albert appears specially susceptible, it also frequently attacks Cox's Orange Pippin, Grenadier and Bismarck (Kitchener).

Frequency of Disease

Not uncommon—appears to be increasing in frequency.

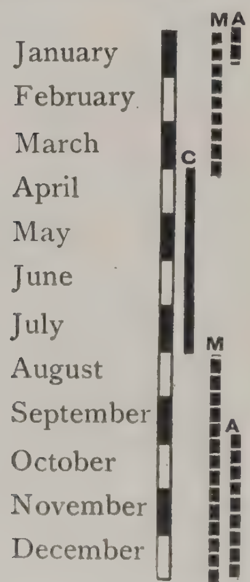
Distribution

Widespread in Europe.

Treatment (Control)

1. Cut away all diseased tips as soon as these are seen, cutting well back beyond the limit of the attacked leaves.
2. Spray in the early spring with LIME-SULPHUR[1] or BORDEAUX MIXTURE[2] (winter strength) before buds burst, or later with a weaker solution of the same.
3. Spray when the fungus is seen with SOFT SOAP[3] and AMMONIUM POLYSULPHIDE[4].

Calendar of Treatment



Spray with strong lime-sulphur[1] or Bordeaux[2].

Cut away diseased tips.

Spray with soft soap[3] and ammonium polysulphide[4].

C = conidial (summer) stage
M = mycelium (spawn) wintering
A = ascigerous (winter) stage (uncommon)

[1] See page 612. [2] See page 609. See page 452. [4] See page 602.

2. Scientific

A. Conidial Stage

APPEARANCE.	White patches resembling flour.
LOCATION.	On tips of shoots and terminal leaves.
APPEARS IN	Summer.
MYCELIUM.	White, external.
HAUSTORIA.	Numerous.
CONIDIA.	
Appearance.	White, oblong.
Arrangement.	Long chains.

B. Ascigerous Stage

LOCATION.	On mycelium.
APPEARS IN	Winter.
PERITHECIA.	
Location.	On mycelium.
Appendages.	1. From apex of perithecium, long, unbranched. 2. From base, wavy, slightly branched.
ASCI.	Oblong.
ASCOSPORES.	Elliptical, hyaline, $22—26 \times 12—14\mu$.

APPLE SCAB (Black Spot)

Name *Venturia inequalis* Order *Ascomycetes*

Plants Attacked

Apples.

Related Diseases

Pear Scab, Cherry leaf Scorch.

1. General

This is the best known, and quite the most important of the fungi attacking apples. The losses annually occasioned by this disease must be very great. Even when the apples are marketable, they are very stunted in size, and realise correspondingly low prices.

Much has been discovered in recent years, both as to the life-history and as regards satisfactory treatment of this disease. It was at first thought to occur only on the fruit, but we now know that the shoots and leaves are affected, and that it is the diseased shoots that are mainly responsible for carrying the disease over from year to year.

The summer or conidial stage of the disease was the only form recognised until recently when Aderhold proved that this is the conidial form of the *Venturia* fungus.

Occurrence and Symptoms

1. *The fruit.*

   This is where growers always notice this disease. It commences to show in the form of small, circular, greenish black spots on the skin of the apples. These increase in size and after a time the familiar scabby patches are produced, due to the dying of these parts of the skin.

2. *The leaves.*

   The fruit is usually *infected from the leaves* which often pass unnoticed. On the leaves the fungus appears as

dark coloured spots, mainly on the upper surfaces. These increase in size and often run together, forming greenish black patches, which, when examined with a hand-glass are seen to have a fibrous appearance towards the margin. The skin of the leaf is ruptured, and spores are produced and set free which infest the fruit.

3. *The shoots.*

The leaves are usually infected from the *year old shoots.* If these are examined in the winter, or best in early spring, the skin or bark will be seen to be wrinkled and often torn and split, and even missing altogether, especially near the base of the previous year's shoot. The exposed portions are generally covered with black patches of the same stage (conidial) of the fungus as attacks the leaves and fruit. Spores are freely produced which are carried by the wind and other agencies on to the young leaves.

Distinguishing Features

This fungus is not readily mistaken for any other on the leaves and fruit. The wounds on the shoots are distinguished from *apple canker* (*Nectria ditissima*) by the appearance of *black* instead of *red* fructifications, and by the fact that the latter causes swelling and callus formation in addition to cracking and injury of the bark.

Effect on Plant

Apples affected with Scab are often distorted, and some varieties show deep cracks extending to the core. These are caused by the drying of the surface, which becomes stiff and unyielding, and the pressure set up by the growth of the fruit causes rupture.

Degree of Damage

Always considerable, varying with season.

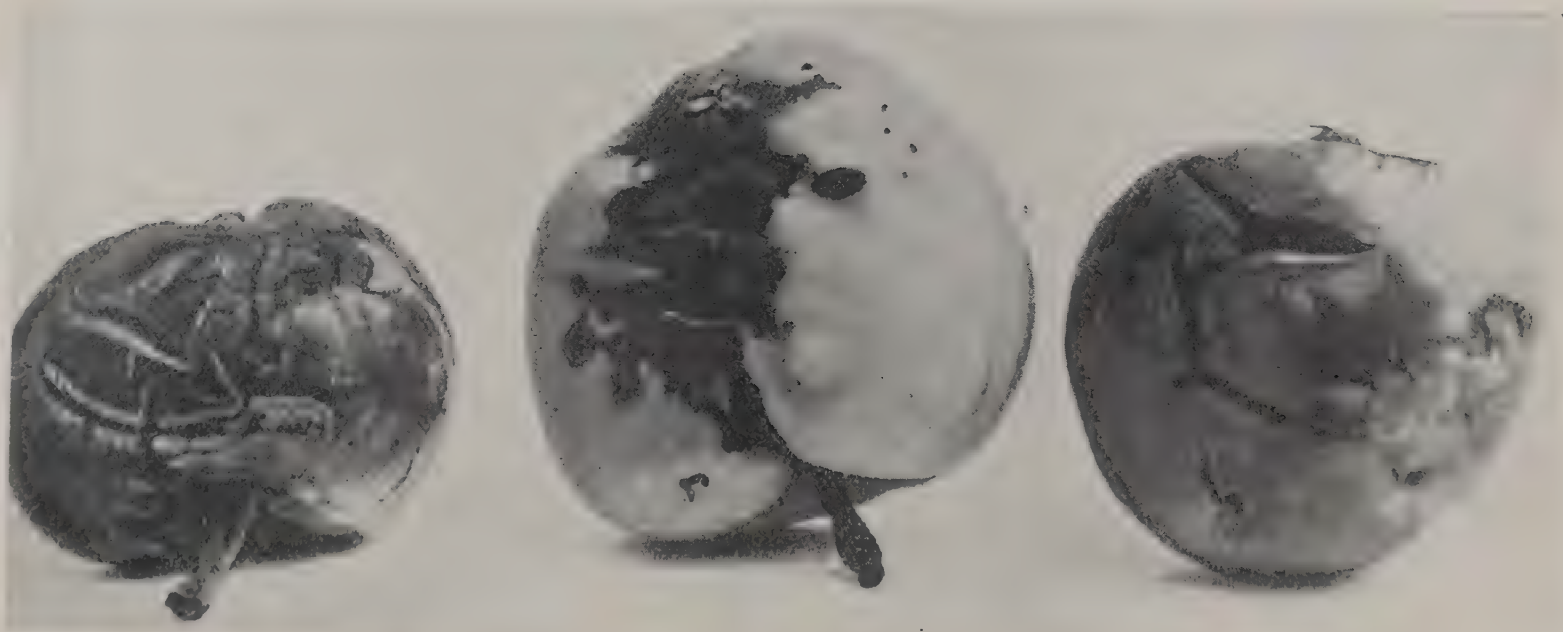


Fig. 236. Apples badly attacked with apple scab fungus. Natural size.

How infection occurs

1. From conidia ("summer spores"), scattered by wind agency, insects, etc., from shoots to leaves and from leaves to fruit.
2. From ascospores (winter spores), from the "winter" (ascigerous) stage produced upon the old leaves.

Conditions favourable to Fungus

Cool and damp weather during spring and early summer.

Susceptible Varieties

Several varieties are so badly attacked that they are going out of cultivation, e.g. Wellingtons and Gladstones. Cox's Orange Pippin is usually very susceptible. Quick growing varieties, such as Bramleys, are less liable to attack.

Frequency of Disease

Very common.

Distribution

Occurs very widely.

Treatment (Control)

1. Cut away and burn all diseased shoots up to the point of the previous year's growth.

   This may be tedious and difficult work, but it is amply repaid, and the other treatment is of much less benefit if this be not first done.

2. Spray with CONCENTRATED LIME-SULPHUR, winter strength (see page 612), early in the year, but as late as it is safe. This is just before the opening of the leaf-buds (see page 616).

   Or

   Spray at same time with full strength BORDEAUX MIXTURE (see page 606).

Fig. 237. Fruit from two adjacent trees: unsprayed (above), winter sprayed with lime-sulphur (below).

Fig. 238. Effect of winter spray with lime-sulphur for apple scab— branch of sprayed tree.

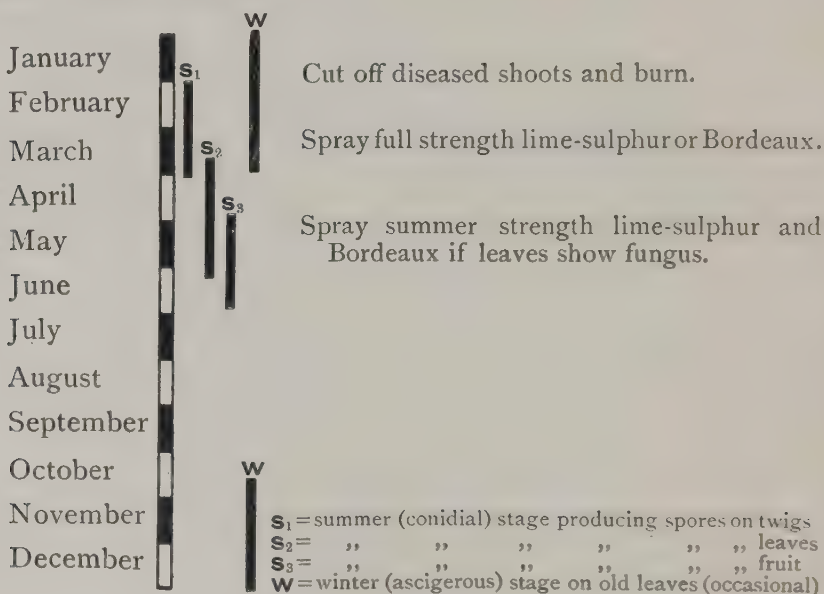
3. If the fungus appears on the leaves in the spring (which should be carefully examined) spray twice, at intervals of 4 to 5 weeks, with summer strength lime-sulphur or Bordeaux (see pages 612, 606).

4. Cut well back and top graft with a quick growing variety, such as *Bramley Seedling.*

Remarks on Remedies

In the case of certain varieties of apples, particularly Cox's Orange Pippin, the leaves are injured by Bordeaux (Bordeaux injury, see page 605), and the summer strength lime-sulphur only must be employed.

Calendar of Treatment



2. Scientific

A. Conidial Stage

Appearance.	Greenish black spots and patches (fibrous on leaves).
Location.	(1) on twigs, (2) on leaves, (3) on fruit.
Appears in	(1) early spring, (2) spring and summer, (3) late spring and summer.

PROPAGATION.	Usually by conidia from this stage on twigs or by the ascospores from the winter (ascigerous) stage.
MYCELIUM.	Greenish black.
CONIDIOPHORES.	Brown, outline wavy; $50-60 \times 4-6\,\mu$.
CONIDIA.	Single, obclavate, yellowish olive; $30 \times 7-9\,\mu$.

B. Ascigerous Stage

LOCATION.	On old leaves.
APPEARS IN	Spring (spores liberated).
PERITHECIA.	
APPEARANCE.	Spherical.
LOCATION.	Embedded in leaf.
ASCI.	Clavate to oblong; $55-75 \times 6-12\,\mu$.
ASCOSPORES.	8, olive-brown, becoming 2-celled; $11-15 \times 5-7\,\mu$.

DISEASES OF THE CHERRY

526 (*a*) Cherry Rot 526 (*b*) Cherry Scab
528 Cherry Witches' Brooms

chromo-lith. Cambridge University Press

PLATE XVI

521 Cherry Leaf Curl　　523 Cherry Leaf Scorch
526 Cherry Mildew　　709 Cherry and Plum Leaf Blight

chromo-lith Cambridge University Press

CHAPTER 31

Diseases of the Cherry

CHERRY BLOSSOM WILT AND CANKER

Name *Monilia cinerea*

This is the same fungus which attacks the Plum and the symptoms and treatment are as described for that disease on page 579. The attack has been investigated by *Wormald.*

CHERRY LEAF CURL

Name *Exoascus minor* Class *Exoascaceæ* Order *Ascomycetes*

Plants Attacked

Cherries

Related Diseases

"Witches'-brooms" (*Exoascus cerasi*), page 528; Peach leaf curl (*Exoascus deformans*), page 557.

General

This disease was first recorded in England by Professor Salmon[1] in the year 1907, and it has occurred in various localities since then from time to time.

Occurrence and Symptoms

When attacked by this disease the leaves of the cherry commence to curl up and become pinkish red in colour. Later, a delicate white bloom appears on the under-surface of the leaves, caused by the fungus fruits, in the form of minute "sacs" containing the spores. These are ejected from the leaves and infest neighbouring branches and trees. The affected leaves then turn brown, decay and drop off the tree. The disease is often confined to one or more leaves on a branch.

The mycelium (spawn) of the fungus passes the winter in the young buds of the cherry, ready to appear in the following spring. Fresh leaves are then affected, the spores appear and the fungus grows along to the new buds and so carries on the disease to a new season.

[1] *Wye Report* 1908, **17**, 320.

Distinguishing Features

The curled and red appearance of leaves in summer.

Effect on Plant

Not great on older trees, but very bad on nursery and young stock.

How infection occurs

By means of spores produced from fungus fruits on leaves in summer.

Susceptible Varieties

Sweet cherries principally attacked.

Frequency of Disease

Not uncommon.

Distribution

Widespread in Europe.

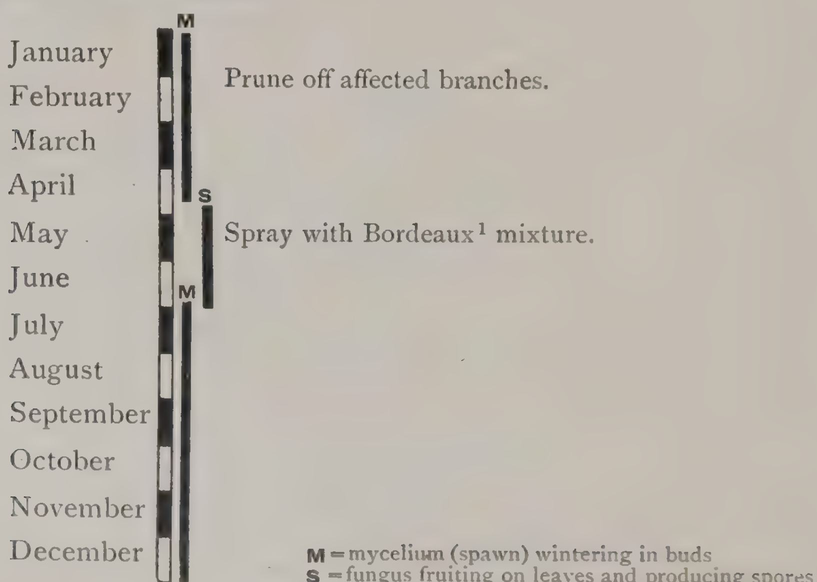
Remarks

The diseased leaves have a characteristic sweet-scented smell resembling new-mown hay.

Treatment (control)

1. Prune off each affected branch well below the affected leaves. This is necessary since the fungus passes the winter in the buds.
2. Spray with BORDEAUX MIXTURE[1] at the time of opening of the leaves.

Calendar of Treatment



[1] See page 606.

CHERRY LEAF SCORCH

Name *Gnomonia erythrostoma* Class *Hypomyces*
Order *Pyrenomycetes*

Plants Attacked

Cherry.

1. General

This serious disease of cherries is now fairly widespread in England and in Europe. Attacked orchards are easily recognised in the winter and spring from the fact that the brown dead leaves remain hanging to the branches, and they are still to be seen even after the flowering of the tree.

Occurrence and Symptoms

The leaves are first attacked in the early summer, and the disease appears as discoloured patches which increase in size. Yellowish at first, the patches soon turn brown and the whole leaf rapidly succumbs, presenting a scorched appearance. This is due to the spawn (*mycelium*) of the fungus spreading to the leafstalk, and cutting off the supply of food. Summer (conidial) spores are produced at this stage, and owing to the invasion of the leafstalk by the fungus, the healthy fall of the leaves in the autumn is prevented and these remain on the tree till they rot away in the following summer.

During the autumn and winter the ascigerous (winter) stage of the fungus is produced, giving rise to spores from the dead leaves in the following spring and early summer which infect the young leaves. The spores are ejected from their cases with considerable force.

The fruit is also attacked, causing it to fall or become distorted.

Distinguishing Features

The scorched appearance of the leaves, and their persistence throughout the winter on the branches.

Effect on Plant

The affected trees gradually weaken, an increasing amount of dead wood is produced and the tree finally dies. The yield of fruit is progressively reduced.

How infection occurs

By means of the summer and winter spores. The latter carry the disease over from one season to the next.

Susceptible Varieties

The sweet cherries are apparently more susceptible to attack than the sour varieties.

Frequency of Disease

Fairly common.

Distribution

Widespread in Europe.

Treatment (control)

Since the new leaves in the spring and summer can become infected only by the spores from the winter stage of the disease on the dead leaves hanging on the branches, the most effective method is to REMOVE THE WITHERED LEAVES during the winter or early spring. The tree is then as healthy as before, because the mycelium (spawn) does not penetrate to the branches.

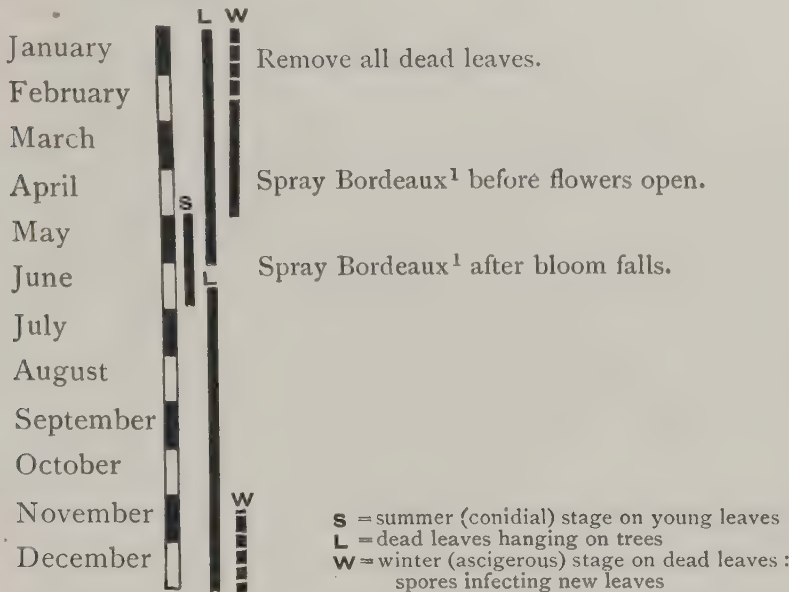
This method, however, still lays the former open to trouble by infection from the untreated orchards of neighbours; and emphasises the necessity for co-operative effort, or for compulsory powers[1].

Also it is often too big a job for the grower to undertake, and for both of these reasons it is preferable to spray the trees so as to cover the young leaves with a protective coating. This is successfully accomplished by spraying with BORDEAUX MIXTURE[2] once, just before the flowers open, and again just after they have fallen.

The disease was stamped out in Germany some years ago by the government compelling all growers to remove the dead leaves from their cherry trees in the affected districts. For this to be of service universal action is of course necessary.

[1] See page 7. [2] See page 604.

Calendar of Treatment



2. Scientific

A. Conidial Stage

APPEARANCE.	Yellow areas becoming brown: fruit in perithecia.
LOCATION.	On leaves.
APPEARS IN	Summer.
DURATION.	Few weeks—dead leaves persist on branches.
MYCELIUM.	In leaf and stalk tissues.
CONIDIA.	On branched sporophores.
Appearance.	Thread-like, hyaline, slightly curved.
Arrangement.	Terminal or nodal, $14-20 \times 1-1 \cdot 5\,\mu$.

B. Ascigerous Stage

APPEARANCE.	As minute black spots (beaks of fruit-conceptacles).
LOCATION.	On dead leaves.
APPEARS IN	Winter and spring.
PERITHECIA.	
Appearance.	Flask shaped with projecting beak.
Location.	In dead leaves.
ASCI.	8 spores.
ASCOSPORES.	Hyaline, ovate, 1-septate, $16-18 \times 5-6\mu$.

[1] See page 604.

CHERRY MILDEW

Name *Podosphæra oxyacanthæ* Class *Erysiphaceæ* (*Powdery mildews*) Order *Ascomycetes*

The fungus attacks cherries in America but is, so far as is known, confined to the Hawthorn in this country at present. Growers are advised to keep a watchful eye for its appearance in their plantations.

CHERRY ROT

See page 497.

CHERRY SCAB

Name *Fusicladium cerasi* Class *Sphæriaceæ* (?) Order *Ascomycetes* (?)

Plants Attacked

Cherries.

Related Diseases

Apple and pear scab (*Venturia*).

1. General

Occurrence and Symptoms

The disease appears in the form of blotches on the ripe cherries. These vary in size and there may be only one or several upon each fruit. They are greenish black and velvety in appearance and later on become scabby.

When the fruit is attacked in an early stage its development is stopped and it often remains on the tree in a partially withered condition for a considerable time.

The leaves and the young shoots are probably first attacked, but this is not at present definitely known.

This disease is probably very closely related to the apple and pear scab (*Venturia*), but, so far, the winter (ascigerous) stage has not been described.

Effect on Plant

Renders the cherries unfit for eating, or prevents their development.

How infection occurs

Probably from summer (conidial) spores scattered by wind, insects etc. from young shoots and leaves.

Frequency of Disease

Not uncommon.

Treatment (Control)

1. Spray with CONCENTRATED LIME-SULPHUR, winter strength (see page 614), early in the year, but as late as possible—i.e. just before the bursting of the buds.
2. When the first signs of the disease appear, spray with
   (*a*) LIME-SULPHUR (summer strength[1]) or
   (*b*) AMMONIUM POLYSULPHIDE and SOFT SOAP[2].

Calendar of Treatment

As for Apple Scab (q.v.).

2. Scientific

A. Conidial Stage

APPEARANCE.	Olive black patches.
LOCATION.	On cherries.
APPEARS IN	May to July.
CONIDIA.	
Appearance.	Oblong with narrow ends, olive coloured.
Arrangement.	$20—25 \times 4—5\mu$.

B. Ascigerous Stage

Unknown.

[1] See page 612. [2] See page 601.

CHERRY WITCHES'-BROOMS

Name *Exoascus cerasi* Class *Exoascaceæ* Order *Ascomycetes*

Plants Attacked

Cherry (wild and cultivated).

Related Diseases

Cherry leaf curl, peach leaf curl.

Fig. 239. Diagram showing cherry tree affected by the witches'-brooms disease.

General

This disease shows itself in a curious tuft or broom of long branches growing out in portions of the tree. The branches are

often much thicker than the remaining healthy ones. In the spring leaves appear but no blossom, and consequently this portion of the tree becomes quite barren.

Occurrence and Symptoms

This abnormal growth of a portion of the tree is caused by the irritation of the mycelium (spawn) of the fungus in the tissue of the branch. The leaves, borne in the spring, soon turn a bright red colour, and afterwards a whitish "bloom" appears on their under surface. This is the fruit of the fungus, and spores are produced which infect the healthy leaves on the rest of the tree. On germinating, the fungus enters the leaf and then grows along to the branch, ultimately producing another "broom" on the tree.

Distinguishing Feature

The "broom" formation.

Effect on Plant

1. The part of the tree affected becomes barren.
2. The tree is weakened by the extra demand made upon its vitality.

How infection occurs

By spores from the fungus-fruit on the leaves (v. s.).

Frequency of Disease

Not uncommon.

Distribution

Widely distributed in Europe.
Not common in America.

Treatment (Control)

1. CUT OUT THE BROOMS as the fungus does not extend downwards into the tree, it will be healthy again.
2. Spray with BORDEAUX MIXTURE[1] in spring and early summer to prevent infection from neighbouring orchards.

[1] See page 606.

Calendar of Treatment

January	Cut out brooms.
February	
March	Spray Bordeaux mixture[1].
April	
May	Spray Bordeaux mixture[1].
June	
July	
August	
September	
October	
November	
December	

M = mycelium (spawn) of fungus in branch of "broom"
S = spores of fungus produced on leaves of "broom" infecting healthy leaves

[1] See page 606.

DISEASES OF THE CURRANT

533 Currant Leaf Spot   535 Currant Rust
583 Raspberry Rust   584 Raspberry Spot

chromo-lith Cambridge University Press

CHAPTER 32

Diseases of the Currant

CURRANT LEAF SPOT

Name *Pseudopeziza ribis* Class *Pezizineæ*
Order *Ascomycetes*

Plants Attacked

Black and Red Currants and Gooseberries.

1. General

This disease is frequently injurious and spreads with great rapidity in a plantation of currants and gooseberries.

Occurrence and Symptoms

The first signs of the fungus usually appear as small black spots mainly on the upper surfaces of the fully grown leaves. These represent groups of the fungus mycelium (spawn) on which the spores are later produced, when the skin of the leaf is ruptured. The spores, which are joined together, issue in the form of minute, viscid hairs, and the spores are liberated and washed off by means of rain.

The winter stage, which has not been found in this country, occurs on the dead leaves. Apparently the summer (conidial) stage is able to infect a plant continuously without the intervention of the winter fruit.

Effect on Plant

In bad cases, the leaves fall early in the season, and this not only checks the fruit crop of a given season, but influences the yield the following year.

How infection occurs

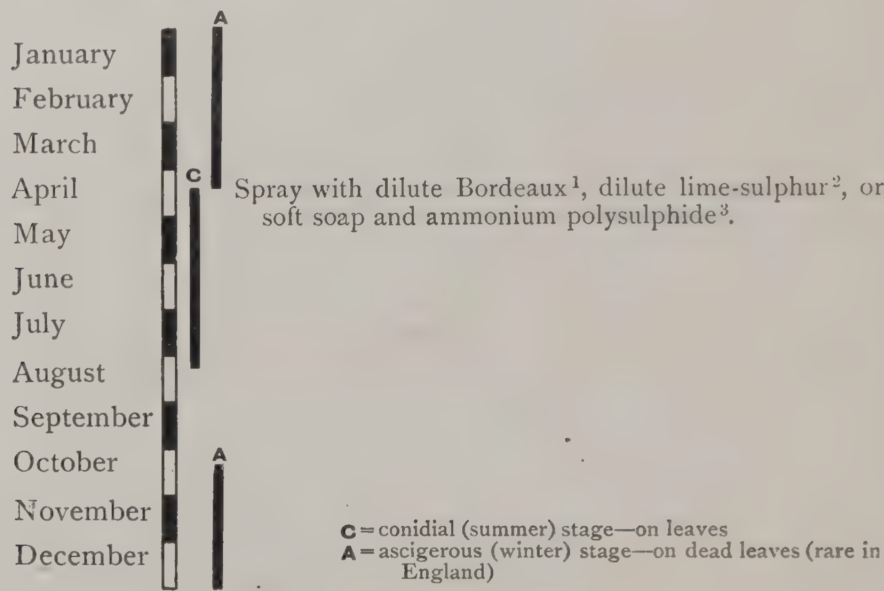
By means of the conidia (summer spores).

Treatment (control)

Spray as soon as the first signs of the disease appear with DILUTE

BORDEAUX[1] MIXTURE, summer strength LIME-SULHUR[2]. Growers are also advised to make trials with SOFT SOAP and AMMONIUM POLYSULPHIDE[3] ("A.P.S.").

Calendar of Treatment



2. Scientific

A. Conidial Stage

APPEARANCE. As black spots bursting through epidermis.
LOCATION. On upper surfaces of leaves.
APPEARS IN Summer.
MYCELIUM. Black: embedded in leaf-tissue.
CONIDIA.
Appearance. Minute, oblong, curved.
Arrangement. Agglutinated in viscid tendril, $10—12 \times 5—6\mu$.

B. Ascigerous Stage (rare in England).

LOCATION. On dead leaves.
APPEARS IN Winter.
MYCELIUM. In tissue of leaf.
ASCI. With 8 spores.
ASCOSPORES. Elliptical, hyaline, $10 \times 6\mu$.

[1] See page 606. [2] See page 612. [3] See page 601.

CURRANT RUST

Name *Cronartium ribicola* Class *Uredinaceæ*
Order *Hemi-basidiomycetes*

Plants Attacked

Currants of all kinds.

One stage of this disease occurs on the pine tree, and the disease on currants is therefore likely to occur in the vicinity of pine plantations. At present the disease has not assumed serious proportions in this country. Spraying has not been found of great success as a remedy.

NETTLE-HEAD OR GOING WILD (REVERSION) OF CURRANTS

See page 704.

DISEASES OF THE GOOSEBERRY

PLATE XVIII.

539 American Gooseberry Mildew   545 Gooseberry Black Knot
543 European Gooseberry Mildew   546 Gooseberry Cluster Cups

chromo-lith Cambridge University Press

CHAPTER 33

Diseases of the Gooseberry

AMERICAN GOOSEBERRY MILDEW

Name *Sphærotheca mors-uvæ* Class *Erysiphaceæ*
Order *Ascomycetes*

Plants Attacked

Gooseberries and occasionally red and black currants.

Related Diseases

Powdery mildews of apple, cherry, hop, strawberry and vine: also European Gooseberry Mildew.

1. General

This serious disease of gooseberries has long been rampant in America, and within the last decade only too familiar to almost every gooseberry grower in England. Its establishment in this country offers one of the most flagrant examples of the danger of allowing untested stock to be imported. So serious did the outbreak become that official action was finally taken, and growers were compelled to notify the occurrence of the disease and were officially advised to grub their bushes when considered necessary. Probably as a result largely of this action the disease is now much less severe, but growers will do well to keep it severely in check by constant spraying.

A recent order dated September 23, 1919, forbids the moving of visibly affected bushes. Occurrence of the disease must be notified and powers are conferred to enforce spraying or grubbing. The two most important clauses are given below.

Occurrence and Symptoms

The disease usually appears first upon the plants about May. A delicate spidery film or web is seen upon the young leaves and buds which soon extends to the shoots and berries and

grows more compact. At first pure white, it soon becomes grey owing to the formation of thousands of summer spores (conidia) which are scattered far and wide by the wind or by insect agency and so spread the disease.

Later on the fungus appears as a **brown felt** upon the berries and shoots. This is the winter or *ascigerous* stage of the disease. Spore cases are produced which liberate winter spores (out of asci) in the early spring and so re-infect the plants.

Distinguishing Features

It can be told from the "*European mildew*" (page 543) by its earlier appearance, and by the latter being usually confined to the leaves, and occurring as small scattered patches. Also by the brown felted appearance of the American mildew.

Effect on Plant

The disease seriously weakens and impoverishes the plant.

Degree of Damage

Not only is the plant affected and weakened, but the berries are rendered unsaleable by the brown felted covering. If marketed, they require special cleaning.

How infection occurs

Chiefly by the summer spores (conidia) which are produced in great abundance. Re-infection of the plant occurs by means of the winter spores (asci) produced the following spring. When a spore falls upon a healthy leaf it germinates and produces a "spawn" or *mycelium* on the leaf, giving off branches which penetrate into the tissue of the leaf and absorb the sap (called *haustoria*). Summer spores and then winter spores are produced in due course.

Conditions Favourable to Fungus

Dull, moist, "heavy" weather.

Susceptible Varieties

Varieties which were at first supposed to be immune have since been attacked.

Frequency of Disease

Very common, though rather less so than formerly.

Distribution

Widespread in England, the Continent, and in America.

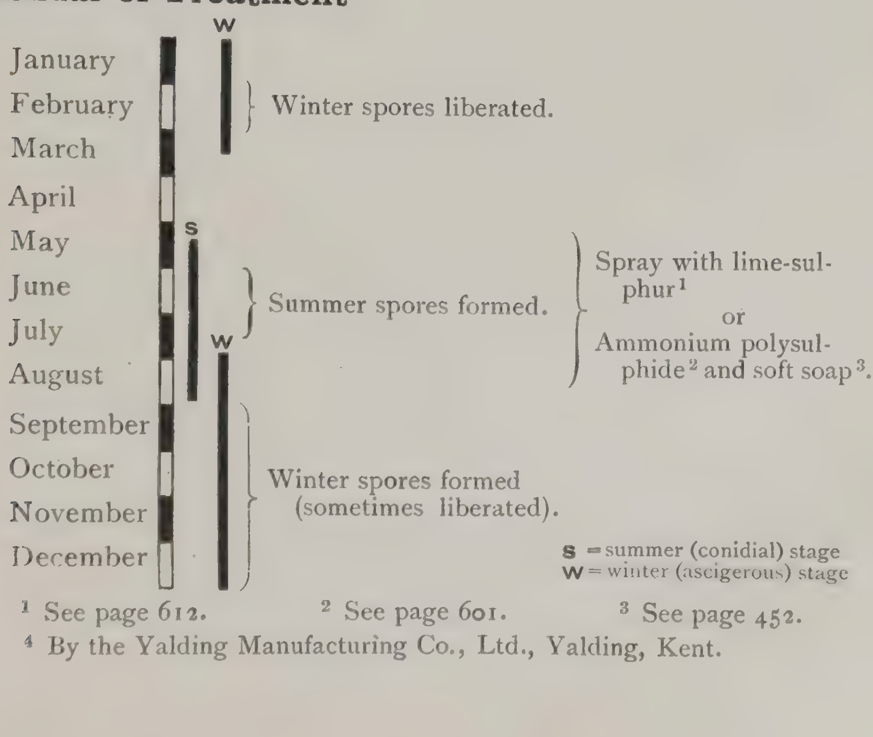
Treatment (Control)

Winter spraying is ineffective owing to the very resistant spore cases (perithecia) of the fungus.

Spraying with *summer strength* LIME-SULPHUR[1] is effective, especially if several sprayings are given. It has the disadvantage of marking the berries with a fine deposit (sulphur) which is quite harmless, but renders them unsightly. These must therefore be cleaned before marketing. (Special machines are available for this purpose.)

The most effective wash, and one which does not mark the berries, is AMMONIUM POLYSULPHIDE[2] and SOFT SOAP[3] ("A.P.S." wash). For details of this spray see page 603. The grower is strongly advised to try this wash, especially as there is a prospect of its being produced at a cheaper rate[4] than has formerly been the case.

Calendar of Treatment



[1] See page 612. [2] See page 601. [3] See page 452.

[4] By the Yalding Manufacturing Co., Ltd., Yalding, Kent.

American Gooseberry Mildew Order, 1919

The following are the main clauses affecting growers:

4. *Prohibition of Movement of Diseased Bushes.*—(1) No diseased bush shall be sold, offered for sale, or moved from any premises until it has been so pruned as to remove all visible traces of disease. An inspector, if he is not satisfied that the diseased bushes on any premises will be pruned before removal as required by this article, may, by notice served on the occupier of the premises, prohibit the removal of the diseased bushes from the premises until he has passed them as being free from visible disease.

(2) An inspector may, by notice served on the occupier of premises to which diseased bushes have been moved in contravention of this article, require him to move the bushes forthwith to the premises from which they were so moved, or alternatively to move the bushes to other suitable premises specified in the notice, and to remove by pruning and to destroy all visible traces of disease before the bushes are again moved.

5. *Powers of Dealing with Disease.*—(1) An inspector may, upon production if so required of his appointment, enter and examine any premises on which gooseberry or currant bushes are growing, and if he finds diseased bushes thereon, and he is not satisfied that the occupier is taking sufficient steps to control the disease, he may, by notice served on the occupier of the premises, require him to adopt one or more of the following measures: (*a*) To destroy all diseased fruit; (*b*) to spray the bushes with a suitable fungicide to the satisfaction of the inspector; (*c*) to prune out and burn forthwith all diseased shoots from each tree or bush.

(2) A notice under this Article may prescribe the time within which the adoption of any measures thereby prescribed shall be completed.

2. Scientific

A. Conidial Stage

APPEARANCE. White, changing to grey.
LOCATION. On young leaves, shoots and berries.
APPEARS IN May and later.
DURATION. Throughout summer.

CONIDIA (summer spores).

Appearance. Oval with rod-shaped bodies in interior (differs from European mildew).
Arrangement. In chains on conidiophores.

B. Ascigerous Stage

APPEARANCE.	As brown perithecia embedded in grey mycelium, turning brown.
LOCATION.	On shoots and berries.
APPEARS IN	Late summer and autumn.
DURATION.	Throughout winter.
MYCELIUM.	Grey, turning brown—felty.
PERITHECIA.	
Appearance.	Dark brown, with simple (unbranched) appendages (differs from European mildew).
Location.	Embedded in mycelium.
Duration.	Usually throughout winter, but not invariably.
ASCI.	Broadly oblong.
ASCOSPORES.	8; $20—25 \times 12—15\mu$.

EUROPEAN GOOSEBERRY MILDEW

Name *Microsphæra grossulariæ* Class *Erysiphaceæ*
Order *Ascomycetes*

Plants Attacked

Gooseberries and occasionally red currants.

Related Diseases

American Gooseberry Mildew, other powdery mildews.

1. General

This disease is fairly common and may be mistaken for the much more serious American mildew (page 539). It is easily however distinguished as follows:

1. European forms delicate threads (mycelium); American dense and woolly.
2. European on leaves chiefly; American chiefly shoots and berries.
3. European remains thin and scanty; American changes to brown felty patches.

The two species may occur on the same plant.

Occurrence and Symptoms

It first occurs on the leaves as delicate greyish white patches of mould which later have a mealy appearance owing to the formation of spores (conidia). It may appear upon both surfaces of the leaf, and is somewhat uncertain in the time of its attack. Later, little black dots appear which are the "winter fruit."

Effect on Plant

If the attack is severe, an early shedding of the leaves may occur.

Degree of Damage

Not usually serious like the allied "American mildew."

How infection occurs

By means of summer spores (conidia) and winter spores (asci).

Frequency of Disease

Not uncommon.

Treatment (Control)

Like all the "*powdery mildews*" the fungus, except for its "roots" (*haustoria*) which are embedded in the leaf tissue, is entirely upon the surface of the plant. It is therefore fairly open to attack.

1. Spray with *summer strength* LIME-SULPHUR (see page 612).
2. Spray with SOFT SOAP[1] and LIVER OF SULPHUR[2], PARAFFIN EMULSION[3] and LIVER OF SULPHUR[2], or, best of all, with SOFT SOAP[1] and AMMONIUM POLYSULPHIDE[4], especially if the attack is severe.
3. Dusting with SULPHUR[5] is effective if the fungus is treated in its earlier stages.

2. Scientific

A. Conidial Stage

APPEARANCE.	Greyish white, delicate.
LOCATION.	Both surfaces of leaves.
TIME OF APPEARANCE.	Erratic.
DURATION.	,,

B. Ascigerous Stage

APPEARANCE.	Small black scattered dots.
LOCATION.	In mycelium.

[1] See page 452. [2] See page 624. [3] See page 417.
[4] See page 601. [5] See page 626.

TIME OF APPEARANCE. Erratic.
DURATION. ,,
PERITHECIA.
Appearance. In scattered groups with characteristic, much branched appendages (different from American).
ASCI. 3—10 ovate.
ASCOSPORES. 3—6, variable in size, $20—30 \times 12—15 \mu$.

GOOSEBERRY BLACK-KNOT

Name *Plowrightia ribesia* Class *Sphæriaceæ*
Order *Ascomycetes*

Plants Attacked

Gooseberries and Currants.

General

This is one of the diseases which gains an entrance to the plant by means of minute wounds caused by aphis or scale attack. No sign of the fungus appears until the branch is dead. It occurs mainly in neglected gardens.

Occurrence and Symptoms

The first sign of the disease is the wilting and yellowing of the leaves which soon afterwards fall off. The branch attacked as a rule lasts over the first year, but in the following spring the early buds only half open and the branch then dies. This is due to the fungus mycelium blocking the plant vessels and so cutting off the supply of sap from the roots.

When the branch is almost dead, large black warts appear on the bark. These are oval and placed with the long axis at right angles to the branch. These are the spore-producing bodies and are often so crowded as to give a blackened appearance to the branch.

Prevention

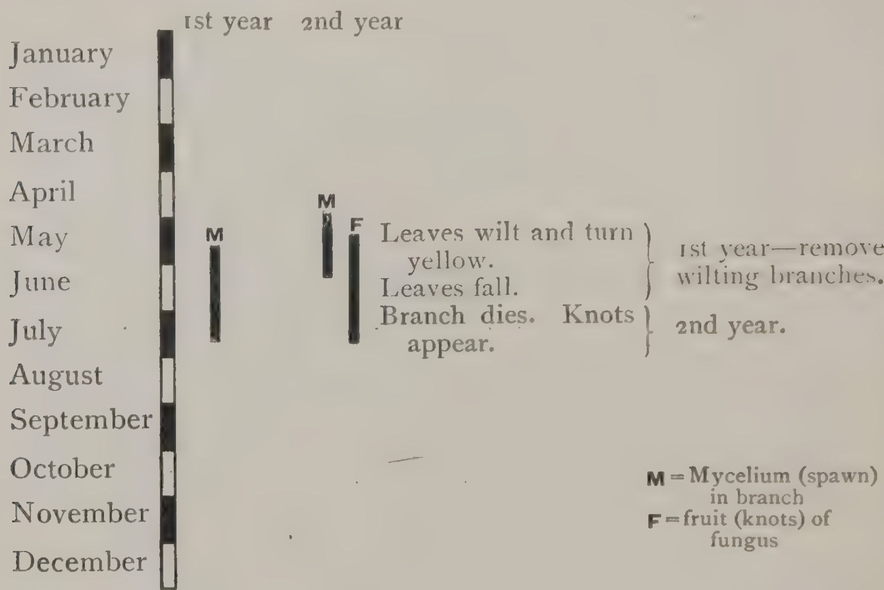
Keep bushes clear of aphides and currant scale.

Remedies

None at present known.

Wilting and yellowing branches should be at once removed.

Calendar of Treatment



GOOSEBERRY CLUSTER-CUPS

Name *Puccinia pringsheimiana* Class *Uredinaceæ*
Order *Hemi-basidiomycetes*

Plants Attacked

Gooseberries.

Related Diseases

Currant and other rusts.

General

This disease occurs with some severity in certain seasons in various places. The reason for this is not at present explained, but weather conditions have probably a large influence. This fungus is one of those which have different forms of spores, and pass a stage of their development on another plant. It is not however essential for this to happen and the disease can propagate itself from year to year on gooseberries alone.

Occurrence and Symptoms

The first sign of the trouble is the appearance of bright orange patches on the leaves and fruit. These patches become later dotted over with minute cup-like bodies, which have white, torn edges and are filled with orange spores.

Another stage of the disease occurs on the leaves of sedges, and appears as brown streaks similar to wheat rust. The winter spores of this stage of the disease infect gooseberries and develop into the characteristic cluster-cup forms. The gooseberry stage can however continue from season to season on the plants without the assistance of the sedges.

Distinguishing Features

The orange patches and toothed edges of the "cups."

Prevention

Cutting down neighbouring sedges in the spring and burning these has been advised.

Remedies

No method has yet met with success. The disease does not often reach serious proportions and the safest plan is to collect and burn the infected leaves and fruit.

DIE-BACK OF GOOSEBERRY

Name *Botrytis* Order *Hyphomycetes*

Plants Attacked

Gooseberries.

General

This disease is now fairly widespread in England and occurs on bushes almost wherever grown. It differs from many other diseases in being propagated from year to year by means of small hard masses of spawn (mycelium) called *sclerotia*. These are very resistant to frost and drought.

Occurrence and Symptoms

The disease may first appear on single plants in a large plantation

or in a small group of bushes amongst other healthy ones. The disease may also attack

1. The main stem.
2. The young wood.
3. The leaves.
4. The berry.

The stem is usually attacked near the ground, and the bush is finally killed at this spot, being "ringed" by the fungus. Several seasons usually elapse before this occurs. Often the spawn (mycelium) of the fungus travels up the stem and kills one or other of the branches. The appearance of dead branches on a bush is characteristic of the disease. At the end of a season's growth the bark peels off, sometimes in large pieces.

The leaves are often infected by the spores and turn yellow or grey at the edges. Sometimes a severe leaf fall occurs, more often the leaves fall normally.

The shoots are also attacked, and the berries are sometimes infected and some rot.

On the dead branches small grey tufts or cushions appear which change into powdery patches. These are the fungus spores. The *sclerotia* also appear as mentioned above.

Treatment (Control)

1. Remove all dead bushes or branches and burn them at once.
2. Any bushes with *main stem* diseased should be burnt.
3. In cases of severe infection, spray with COPPER SULPHATE solution (see page 611), 4 lbs. to the 100 gallons of water, just before buds burst. The main stems should be thoroughly wet.
4. Spray immediately the fruit is set with BORDEAUX MIXTURE (8 . 8 . 100), see page 606.

DISEASES OF THE HOP

547 Die-back of Gooseberry   551 Hop Mildew
567 Plum (*a*) Leaf Blight, (*b*) Blister, (*c*) Rust
570 Plum Silver Leaf (*a*) leaf, (*b*) dead trunk, (*c*) dead branch

chromo-lith Cambridge University Press

CHAPTER 34

Diseases of the Hop

HOP MILDEW (mould)

Name *Sphærotheca humuli* Class *Erysiphaceæ* (*Powdery mildews*) Order *Ascomycetes*

Plants Attacked

Hops: a kindred "strain" or "variety" of the same fungus occurs on strawberries and many wild plants, as geranium, meadow sweet, agrimony, etc., but Salmon has shown that this is not capable of infecting the hop.

Related Diseases

Gooseberry, vine, apple, and other mildews.

1. General

The hop mildew or "mould" is a constant and serious menace to hop cultivation, second only in its harmful effects to the hop aphis ("fly").

It appears with varying degrees of severity practically every year, especially when the situation of the garden is much sheltered or the soil badly drained.

The great aim of the hop grower is to deal with the mildew before it has an opportunity to establish itself on the cone or "pin." Once this is infected the whole crop may be ruined as the flavour and keeping qualities of the hop are endangered. It is safest to take prompt action whenever the least trace of mould is first seen and before it spreads over the garden and obtains a "hold."

Occurrence and Symptoms

The first sign of the mildew is the occurrence either on the upper or lower surface of the leaf of delicate white patches. These tend to increase in size until the whole leaf surface becomes covered.

Later the mildew becomes grey and "mealy," due to the formation of the summer spores (conidia) in enormous numbers. The winter spores (in perithecia) are formed later, or may not occur at all, the fungus disappearing from the leaf altogether under conditions which are unsuitable to its growth—such as dry, sunny weather. When found, the winter spores occur in minute black bodies.

Distinguishing Features

Not likely to be mistaken for any other fungus disease on hops.

Effect on Plant

Not usually serious as long as it is confined to the leaves.

Degree of Damage

Very serious if allowed to spread to the "burr" or "pin."

How infection occurs

Mainly by means of the summer spores (conidia), but the winter spores probably carry the disease over to the following season.

Conditions Favourable to Fungus

Dull "heavy" weather, and a too sheltered position of the garden, also lack of adequate drainage of the soil, producing an unhealthy "water-logged" condition.

Frequency of Disease

Common.

Distribution

Occurs wherever hops are grown.

Treatment (Control)

1. PREVENTION

   Avoid low-lying situations.

   Ensure adequate drainage of soil.

2. REMEDIES

   Measures should be taken immediately any signs of the fungus are seen. In certain seasons the mould is very persistent and will require continuous treatment throughout the season. If the weather is bright and sunny, with light breezes, there will probably be little to fear, but as it is impossible to predict what the conditions will be, it is always the best plan to anticipate the worst. The most usual, and on the whole satisfactory, remedy is the dry spraying or dusting of SULPHUR, termed "sulphurating." The finest grades of sulphur obtainable should be used, these are "FLOWERS" and "PRECIPITATED SULPHUR" (see page 626).

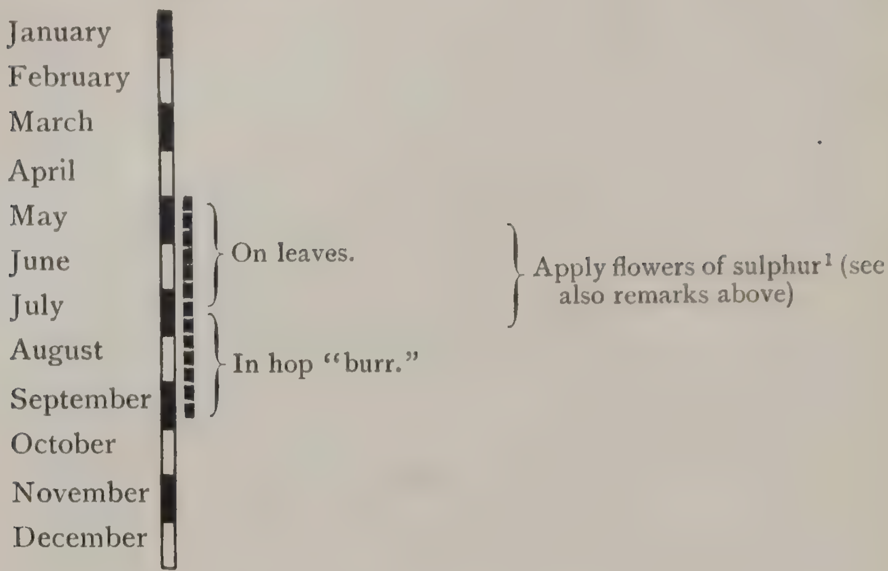
   Certain weather conditions[1] are more favourable to the action of sulphur than others. Many growers can tell by the odour of their gardens after sulphurating if it is in an active condition. The exact manner in which it acts is not fully understood, there being rival theories on its action.

   Many growers like to use a small quantity of *liver of sulphur* in their final soap spray, when the burr is appearing. This has been shown to be of little value, unless sufficient is used to become dangerous to the hops.

   It is possible that ammonium polysulphide and soft soap ("A.P.S." wash, see page 601) used weak would be more efficient for this purpose, as has been proved in the case of American Gooseberry Mildew. This might be used with advantage in the early stages of growth. If tried when the hop is in burr, great caution must be employed in adjusting the strength of the spray, so that the "pin" is not injured. No recommendation as to strength can at present be made, the grower should himself experiment on a small scale before using any large quantities.

[1] Apparently bright sunny weather most favourable, but wind is detrimental.

Calendar of Treatment



2. Scientific

A. Conidial Stage

APPEARANCE.	As delicate white patches becoming grey.
LOCATION.	On both surfaces of leaves.
TIME OF APPEARANCE.	Very uncertain.
DURATION.	Variable.

B. Ascigerous Stage

MYCELIUM.	Greyish white.
PERITHECIA.	
APPEARANCE.	Small, black, with long brown appendages.
LOCATION.	In mycelium.
DURATION.	Variable.
ASCI.	Single, 8-spored.
ASCOSPORES.	Elliptical, $22 \times 15\,\mu$ (average).

[1] See page 626.

DISEASES OF THE PEACH

PLATE XX

588

557

557 Peach Leaf Curl
588 Strawberry Mildew

chromo-lith Cambridge University Press

CHAPTER 35

Diseases of the Peach

PEACH LEAF CURL

Name *Exoascus deformans* Class *Exoascaceæ*
Order *Ascomycetes*

Plants Attacked

Peaches, nectarines and almonds.

Related Diseases

"Witches'-brooms" of Cherry, and Cherry Leaf Blister.

General

This disease occurs fairly commonly on peaches, and is a serious menace to their cultivation in certain districts. It is more prevalent in the case of plants grown in the open. It occurs all over the world where peaches and allied plants are grown.

Occurrence and Symptoms

The appearance of this fungus is very characteristic. The leaves remain green at first, but become distorted and crumpled, later they turn yellow with a reddish tinge and finally change to a rosy red. Later still a silvery bloom appears upon the surface, due to the fruiting stage of the fungus.

Unfortunately this disease penetrates into the interior of the shoots and remains there throughout the winter, passing into the new buds in the following spring. Spraying is therefore of little use, except as a preventive of attack.

Distinguishing Features

The crumpled distorted leaves, turning red.

How infection occurs

By means of spores carried by the wind or insect agency. The fungus threads apparently remain in the branches and occasionally grow up the expanding leaflets the following spring. More usually however plants are re-infected by spores which have lain dormant during the winter on the bud scales.

Frequency of Disease

Fairly common.

Treatment (Control)

Thorough spraying with BORDEAUX[1] or BURGUNDY[2] mixture is an effective treatment. The spray must be applied before the buds begin to swell in the spring. This period usually covers the time between middle February and the first or second week in March. Before spraying, all dead and diseased shoots should be cut away. One spray should suffice but a second application lessens any chance of failure.

[1] See page 606.

[2] See page 610. A double-strength Burgundy mixture of the following composition was found effective at Wisley (see *Jour. Board of Agric.* 1919, XXVI, No. 8): copper sulphate $2\frac{1}{2}$ lbs., carbonate of soda (crystals) $2\frac{3}{4}$ lbs., water 12 gallons.

DISEASES OF THE PEAR

561 (*a*) Pear Cluster Cups 561 (*b*) Pear Leaf Spot
564 Pear Scab

chromo-lith Cambridge University Press

CHAPTER 36

Diseases of the Pear

PEAR LEAF CLUSTER-CUPS

Name *Gymnosporangium sabinæ* Class *Uredinaceæ*
Order *Basidiomycetes*

Plants Attacked

Pears.

Related Diseases

Gooseberry Cluster-cups (page 546).

Occurrence and Symptoms

The disease occurs as clusters of cup-like bodies on yellowish spots on the leaves. Another stage of the disease appears on juniper trees. When pears are badly attacked the leaves are shed early in the season.

Treatment (Control)

No treatment at present known appears to have much effect, although an early spraying with weak BORDEAUX MIXTURE[1] should be a preventive against attack, as the pears are probably infected from the junipers in the spring, or early summer.

PEAR LEAF SPOT

Name *Mycosphærella sentina* Class *Sphæriaceæ*
Order *Ascomycetes*

Plants Attacked

Pears.

Related Diseases

Strawberry leaf blight.

[1] See page 606.

1. General

This is a common disease of pears, especially attacking nursery stock. It is one of those diseases in which the winter spores are developed on the dead leaves, and for this reason it is useless to expect to cure by spraying unless the fallen leaves are removed and destroyed.

Occurrence and Symptoms

Small round spots appear on the pear leaves, especially upon the upper surfaces. These spots become greyish as the leaf tissue dries up, and are surrounded by a brown border. If the under surfaces of the leaves are carefully examined, the fruiting stage of the fungus will be seen in the form of minute black points on the diseased areas (a hand-glass is sometimes necessary to distinguish them).

The winter fruit developes upon fallen leaves and the spores produced infect the young leaves in the following season.

Effect on Plant.

When the leaves are much spotted, they turn yellow and fall early in the season.

No direct damage is done to the fruit, but the crop naturally suffers through the weakening of the tree.

How infection occurs

A. By the "summer" spores on the living leaves.

B. In the following year, by the "winter" spores from the fruiting stage on the dead leaves.

Frequency of Disease

Fairly common.

Distribution

Very general wherever pears are grown

Treatment (Control)

Great benefit has been found from spraying with weak BORDEAUX[1] MIXTURE. LIME-SULPHUR[2] (summer strength) is however equally effective and less liable to injure the leaves. The first spraying should be given immediately after the petals fall, and two more at intervals of three weeks after.

Fallen leaves must be destroyed.

[1] See page 606. [2] See page 612.

Calendar of Treatment

January	
February	
March	Spray dilute Bordeaux[1] or lime-sulphur[2] when petals fall.
April	
May	Spray again.
June	Spray again.
July	
August	Destroy fallen leaves.
September	
October	
November	
December	

C = conidial (summer) stage on young leaves
A = ascigerous (winter) stage on fallen leaves

2. Scientific

A. Conidial Stage

APPEARANCE.	As minute black perithecia on diseased areas.
LOCATION.	Under surfaces of leaves.
APPEARS IN	Summer.
CONIDIA.	
Appearance.	Long, slender, curved, 3-celled.
Arrangement.	As viscid tendril, 60×3—4μ.

B. Ascigerous Stage

APPEARANCE.	As globular perithecia with projecting mouth.
LOCATION.	On fallen leaves.
APPEARS IN	Winter and spring.
ASCI.	8-spored, 60—75×11—13μ.
ASCOSPORES.	Hyaline, slightly curved, 26—$33 \times 4\mu$.

[1] See page 606. [2] See page 612.

PEAR SCAB

Name *Venturia pyrina* Class *Sphæriaceæ* Order *Ascomycetes*

Plants Attacked

Pears.

Related Diseases

Apple Scab (page 510).

Occurrence and Symptoms

This disease very closely resembles Apple Scab (page 510), in all respects, except that the attacked fruit tends to *split* and *crack* much more often than in the case of apples. The winter fruit of the fungus occurs on the dead leaves.

Treatment (Control)

As in the case of Apple Scab (page 513).

Scientific

CONIDIAL STAGE

Velvety, olive-black, conidiophores short, outline wavy or knotted; conidia 28—30 × 7—9μ.

ASCIGEROUS STAGE

Perithecia in colonies on dead leaves (under surface). Asci, 8-spored; spores 14—20 × 5—8μ.

DISEASES OF THE PLUM

568 Plum Pockets — 569 (*a*) Plum Rot
569 (*b*) Plum Scab — 578 Plum Wither Tip

CHAPTER 37

Diseases of the Plum

PLUM LEAF BLIGHT (*Cylindrosporium padi*)

See Cherry Leaf Blight, p. 709.

PLUM LEAF BLISTER

Name *Polystigma rubrum*

Plants Attacked

Plums and damsons.

Occurrence and Symptoms

The fungus forms large orange-reddish patches of a dull appearance, best seen on the under surface of the leaf. With a hand-glass, very fine pits or holes can be seen on the patches which are the openings through which the spores are ejected. The winter form occurs on the fallen leaves.

Control

The disease is not often sufficiently severe to warrant the expense of spraying. All dead leaves should be cleared off the orchard and destroyed.

PLUM LEAF RUST

Name *Puccinia pruni* Class *Uredinaceæ* Order *Ascomycetes*

Plants Attacked

Plums chiefly, also cherries and peaches.

Related Diseases

Raspberry Rust (see page 583).

Occurrence and Symptoms

The disease occurs as small brown spots on the under surfaces of the young leaves. In favourable weather the disease rapidly spreads, and frequently causes an early leaf fall, thus affecting the quality and yields of the fruit.

Control

Spraying with summer strength LIME-SULPHUR[1] or BORDEAUX[2] is the best way of dealing with an attack, if sufficiently serious. It is best to give two sprayings, one when the first signs of the disease are seen, and another about a month later.

PLUM POCKETS

Name *Exoascus pruni* Class *Exoascaceæ* Order *Ascomycetes*

Plants Attacked

Plums.

Related Diseases

Peach Leaf Curl, Witches'-brooms of Cherry.

Occurrence and Symptoms

The disease is first seen about three weeks after the blossom has fallen. The young fruit then appears swollen owing to the excessive growth of the flesh of the fruit, the stone remaining quite small.

As it grows the fruit becomes much twisted and curved, and hollow in places. The colour, at first pale green, becomes afterwards reddish or purplish and much wrinkled.

The fruiting stage of the fungus is produced upon the diseased plums, appearing as a delicate bloom on the surface of the skin. Spores are produced which infect the shoots, and the fungus threads pass into the flowers and young fruitlets. The threads of the fungus remain in the tissue of the shoots all the year round and so infect the flowers each year.

Treatment (Control)

As the fungus remains in the shoot, spraying is useless as a remedy. Branches bearing diseased plums should be in all cases removed, if possible, before the fruiting of the fungus, i.e. as early as possible. Cut surfaces are best protected by a coating of Stockholm tar.

[1] See page 612. [2] See page 606.

PLUM ROT

Name *Sclerotinia fructigena*

Plants Attacked

Apples, cherries, plums.

General

This is the same disease which attacks apples (see page 497). The disease on plums is not quite the same in appearance, but more like that on cherries (page 526). The fungus occurs in isolated patches, and not in circles as on apples, but the mummified fruit is formed in the same manner, and all other remarks apply as in the case of apples.

PLUM SCAB

Name *Cladosporium carpophilum*

Occurrence and Symptoms

This is a disease very similar in all respects to Cherry Scab (see page 526) and is treated in the same manner. It is somewhat rare in this country.

SILVER LEAF

Name *Stereum purpureum* Class *Thelephoreæ*
Order *Basidiomycetes*

Plants Attacked

Chiefly plums, but apples are also not uncommonly attacked, and also cherries, peaches, gooseberries, currants, and apricots. Many other trees besides fruit trees liable to disease, the commonest being horse-chestnuts, sycamores and laburnums.

General

The disease known as "Silver Leaf" is becoming, especially in certain districts, a very serious scourge to fruit-growers. In fact, it is not too much to say that unless energetic steps are taken to prevent its spread, it will seriously interfere with the cultivation of plums in this country. Many growers, as the author has found in his frequent visits to fruit-growing districts, are quite unaware of the risk they incur in allowing diseased trees to remain in their orchards year after year. Fortunately government action has now been taken and definite directions laid down to ensure that prompt measures are taken to control the disease. In the meantime, all growers should, in their own interests, lose no time in grubbing up, or at least felling[1], all badly diseased trees without waiting for the visit of the inspector.

The text of the order, referred to as Silver Leaf Order, 1919, is given below.

Cause of the Disease

As far as our knowledge at present goes, it is not certain that all cases of "*silver leaf*" are caused by fungus attack. This

[1] If the roots are left, the main trunk must be covered over with at least six inches of soil (see page 576).

is however not of great importance to the fruit-grower. What has definitely been proved is that the fungus known as *Stereum*

Fig. 240. Two plum leaves. Healthy (left) and affected with silver leaf disease (right). Natural size.

can, and does, produce the silver leaf disease in plums, and that the spores of the fungus are able to carry and spread the disease far and wide.

It has also been proved that the disease on a tree is not infectious until the fruiting stage has appeared upon portions of dead wood on the branches or elsewhere.

If, therefore, a tree showing silver leaf is kept free from dead wood, there is no danger of infection to neighbouring trees. Since however it is easy to overlook small portions of dead branches, it is advisable, and in fact necessary in practice, to cut away all branches showing the silvering of the leaves before any portion is actually dead, and trees showing the disease all over should be ruthlessly grubbed up and *burnt at once.*

Occurrence and Symptoms

The following is the normal course of the disease:

1. Generally speaking, the disease appears first on a single branch of the tree. The leaves develop an unmistakable silvery or leaden sheen (see figs. 240, 241).

   This appearance is caused by air spaces forming beneath the skin of the leaf, due to a splitting of the tissues in the interior of the leaf.

2. Other branches become affected in the same manner, some of the leaves often showing brown streaks and stains.

3. Affected branches commence to die back, or the entire branch dies suddenly. At this stage, the whole tree often becomes affected, all the leaves appearing "silvered."

4. The fruiting stage of the fungus appears upon the dead wood. It occurs usually as *purplish crusts* crowded together in irregular rows (fig. 242 and coloured plate). Sometimes it appears as a long strip on the under surface of the branch, or on the side of the trunk.

   In dry weather, the crusts shrivel up and darken in colour. They are not then so readily seen. Countless spores are liberated, especially during damp weather, and these are able to infect with the disease any tree on which they alight, provided that entrance can be obtained through a wound, which may be very slight.

Fig. 241. Two branches of plum; healthy (left), affected with silver leaf disease (right), reduced.

5. The whole tree finally dies.

In addition to the fungus producing the silvering of the leaves, it also usually stains the wood of the branch brown, owing to the formation of a gummy substance. This can be seen on severing the branch and examining the cut surface.

Effect on Plant.

In the case of plums, the affected trees usually die sooner or later.

Affected apple trees sometimes recover of themselves and appear to be able to throw off the disease more readily. The yield and quality of the fruit is generally seriously affected almost at once, although exceptions occur to this.

How infection occurs

As stated above the disease is spread by a spore of the fungus gaining an entrance to a healthy tree through some wound. The wound may be so small as to be invisible to the eye, but there is of course more liability to infection if cut surfaces of the tree, etc. are left unprotected.

Spores may originate not only from diseased fruit trees but also from other trees and from dead wood.

Susceptible Varieties

Although *Victorias* and *Czars* appear most often attacked, this is probably because they occur more commonly.

No varieties have been found to be immune from the disease.

Frequency of Disease

Increasingly common.

Distribution

All districts where plums are grown in England are affected. It is less common on the continent and in America.

Fig. 242. Fruiting stage of *Stereum purpureum*, the fungus causing silver leaf disease, on dead branch of plum. Inset, a fungus growth magnified.

Treatment (Control)

Although much research has been carried out, no reliable cure has been found for the disease.

Inoculation experiments appeared to give at one time hopeful results. Trees were plugged with sulphate of iron which was inserted in holes bored in the trunk. Success was not however achieved in practice and the method is not recommended.

It only therefore remains to take stringent precautions against the spread of the disease as follows:

A. SLIGHTLY AFFECTED TREES.

1. Cut back all branches showing silvered leaves to a point at which no brown stain appears in the wood.
2. Even up all cut surfaces, and coat them over with Stockholm tar.
3. Take care to *burn all branches at once* (otherwise the fungus may fruit on the dead branch).
4. If the work *cannot* be done when the leaves are on the trees, mark plainly those branches which are silvered so that they may be removed in the autumn. It is much safer to do the work at once, as the fungus usually fruits in the autumn.

B. TREES WITH DEAD BRANCHES.

The dead wood should be cut off and *burnt at once*, as grave risk is incurred by leaving any dead wood on affected trees.

C. DEAD OR DYING TREES (including trees with leaves entirely silvered).

These should be *completely grubbed up*. If it is not possible to take up the roots, it should be cut down to the ground as closely as possible and the stump well charred and covered over with at least six inches of earth. Otherwise the fungus is liable to fruit on the exposed wood and become a source of infection.

Large branches and trees should be immediately cut up for firewood. If this is not at once used, it must not be stored near the plantation, and should be placed under cover as far away as possible.

SILVER LEAF ORDER, 1919

The Official Text

The full text of the Order of the Board of Agriculture, dated Nov. 24, 1919, entitled the Silver Leaf Order, 1919, is as follows:—

The Board of Agriculture and Fisheries, by virtue and in exercise of the powers vested in them under the Destructive Insects and Pests Acts, 1877 and 1907, and for the purpose of preventing the spreading in England and Wales of the pest known as Silver Leaf, which is destructive to fruit trees and bushes, do order as follows:—

Definitions.—1. The expression "the Board" means the Board of Agriculture and Fisheries; the expression "plum trees" includes any stock, stool or cutting of a plum tree; "Inspector" means an Inspector of the Board or of the Local Authority; "The Local Authority" means as regards any District the Local Authority for the District under the Diseases of Animals Act, 1894.

Destruction of Dead Wood.—2. (1) The occupier of any premises on which plum trees are growing shall cut off and destroy by fire on the premises all the dead wood of each plum tree before April 1 of each year, and, where the dead wood in the trunk of any such tree extends to the ground, the occupier shall grub up and destroy by fire upon the premises the whole of any such tree, including the roots, before that date.

(2) An Inspector may at any time serve a notice on the occupier of any premises requiring him to cut off and destroy by fire within the time specified in the notice and on the premises any dead wood of any tree or bush of any kind whatsoever on the premises on which there are visible fruiting bodies of the fungus *Stereum purpureum.*

Power of Entry.—3. Any Inspector of the Board or of the Local Authority upon production if so required, of his appointment, may for the purpose of enforcing this Order enter any premises on which he has reason to suspect that a tree or bush to which this Order applies, is or recently has been, and examine any such tree or bush thereon and any wood cut from any such tree or bush.

Service of Notices, &c.—4. (1) For the purpose of this Order a notice shall be deemed to be served on any person if it is delivered to him personally or left for him at his last known place of abode or business, or sent through the post in a letter addressed to him there; and a notice purporting to be signed by an Inspector shall be *prima facie* evidence that it was signed by him as an Inspector.

(2) A copy of every notice served under this Order shall be sent to the Board by the Inspector by whom the notice is signed.

Notification of Order.—5. This Order shall be published by the Local Authority in accordance with any directions given by the Board.

Offences.—6. Every person shall be liable on conviction to a penalty not exceeding ten pounds who:—

(1) fails to comply with the requirements of this Order, or of any notice served under this Order, or

(2) wilfully obstructs or impedes any Inspector in the exercise of his powers or duties under this Order.

Commencement.—7. This Order shall come into operation on the first day of January, 1920.

Application of this Order.—8. The Order shall apply to England and Wales.

PLUM WITHER-TIP AND BLOSSOM WILT

Name *Monilia cinerea*

Plants Attacked

Plums; probably another "strain" of the same disease which attacks apples (as "Blossom Wilt" disease, page 494). Cherries are also attacked (page 521).

Related Diseases

"Brown rot" of fruit (*Sclerotinia fructigena*).

1. General

This disease was first noticed and investigated by *Wormald*[1]. It is apparently a "strain" or variety of the same fungus which attacks apples, producing the "Blossom Wilt" of apples, a disease also investigated by Wormald.

[1] *Annals of Applied Biology*, 1918, **VI**. p. 28.

These are both allied to the Brown Rot disease of apples and other fruits.

The fact that it is not identical with the Blossom Wilt fungus is proved from the effect of innoculating apple blossoms with the Plum Wither-tip spores. If this is done, the apple blossoms are killed, but the disease extends no farther into the branch.

Although only recently investigated, the disease is probably quite an old one, but has passed unnoticed or been attributed to frost or other causes.

Occurrence and Symptoms

The first sign likely to be noticed by the grower is wilting of the blossoms and the withering of the tips of the young twigs early in the season. These curve over in a characteristic manner. Infection is caused through the spores on the leaves, and the fungus then penetrates to the shoot, causing the death of the tip so affected. A discoloured area is formed on the shoot, which dries up at this point, and cuts off the sap to the young leaves. During the following winter and spring, grey pustules of the fungus fruit are borne on the dead twigs.

The fungus appears also as dark grey pustules on the fruit which becomes mummified on the trees.

Distinguishing Features

The withering and wilting of the young tips of the twigs which remain on the tree throughout the winter. The dark grey fungus on the fruit.

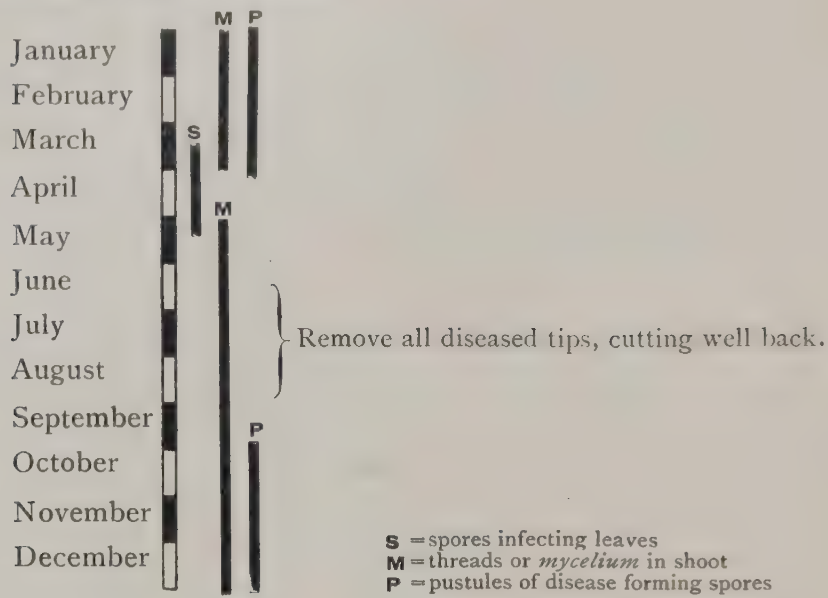
How infection occurs

Through the germination of the spores of the fungus, borne in the winter and spring on the withered tips, and infecting fresh blossoms and tips.

Treatment (Control)

Spraying is of little use as far as our knowledge of the disease extends at present. All withered shoots and tips, and all fruit affected with "brown rot" should be removed from the trees before the pustules of the disease are produced, i.e. in autumn. Care should be taken to cut well below the diseased portions.

Calendar of Treatment



2. Scientific

A. Conidial Stage

APPEARANCE.	Occurring as grey pustules.
LOCATION.	On withered tips of shoots.
APPEARS IN	Late autumn or winter.
DURATION.	Till following spring and summer.
CONIDIA.	Size variable; from pustules on twigs, $5—10 \times 5 \cdot 5—17\mu$[1].

B. Ascigerous Stage

Unknown in this country.

[1] Wormald, *Annals of Applied Biology*, 1918, **VI**, p. 34.

DISEASES OF THE RASPBERRY

CHAPTER 38

Diseases of the Raspberry

RASPBERRY RUST

Name *Phragmidium rubi-idei.* Class *Uredinaceæ*
Order *Basidiomycetes*

Plants Attacked

Raspberries.

Occurrence and Symptoms

This fungus produces three kinds of spores (as in all fungi of this class) and they all occur on the raspberry leaves.

The first appearance of the disease is in midsummer on the upper surfaces of the leaves, which become dotted with yellowish pustules, usually with a more or less circular arrangement.

Another fruiting stage occurs shortly after, similar in appearance to the first except that the pustules have an orange tint. The third form of the fungus fruit appears as small black clusters on the under surfaces of the leaves.

Treatment (Control)

There is not much hope of a cure by means of spraying. As however spraying with liver of sulphur has been advised the author suggests that a spray with AMMONIUM POLYSULPHIDE and SOFT SOAP as soon as the disease appears (see page 601) would probably be better. Lime-sulphur cannot be used as it would disfigure the berries, unless these have been picked. The summer strength should then be employed[1]. Bordeaux mixture is liable to scorch the leaves severely.

Scientific

Ascidiospores.	Yellowish, 20—28μ diameter.
Uredospores.	Orange, 16—22μ.
Teleutospores.	Black, oblong, warted, 5—10 septate, 90—140 × 20—35μ.

[1] See page 612.

RASPBERRY SPOT

Name *Glœosporium venetum*

Plants Attacked

Raspberries, also cloudberries.

Occurrence and Symptoms

The canes become spotted with small red spots which increase in size and form blotches. Later they become paler with a dark red border. The leaves are occasionally attacked.

Treatment (Control)

1. Cut out the infected canes as soon as these are seen, so as to prevent the spread of the disease, which is very rapid.
2. Spray with summer strength LIME-SULPHUR[1]; the author suggests a trial with AMMONIUM POLYSULPHIDE[2] and SOFT SOAP[3].

[1] See page 612. [2] See page 601. [3] See page 452.

DISEASES OF THE STRAWBERRY

587 Strawberry Leaf Spot

chromo-lith. Cambridge University Press

CHAPTER 39

Diseases of the Strawberry

STRAWBERRY LEAF SPOT

Name *Sphærella fragariæ.* Class *Sphæriaceæ*
Order *Ascomycetes*.

Plants Attacked

Strawberries, also wild varieties.

General

This disease is fairly common and is known to most cultivators of strawberries. The fruit crop is not commonly injured seriously, unless the disease is severe.

Occurrence and Symptoms

The first sign of the disease is the appearance of small patches of red discoloration on the leaves. As time goes on these will increase in size and some overlap, forming large patches. The colour then changes in the centre to a grey tint due to the death of this part of the leaf. The patch is usually bordered by a ring of bright red. Later still, minute white tufts of the summer (conidial) fruit appear and these give rise to the summer spores which infect other leaves. On old and dead leaves the winter fruit of the fungus appears as minute black spots. These produce the winter spores, which are capable of infecting the young leaves in the following season.

Effect on Plant

In severe cases the fruit crop is badly affected, both in yield and quality, and the plant is severely weakened.

How infection occurs

By means of the winter and summer spores liberated from the two kinds of the fungus fruit. These are able to infect healthy leaves.

Frequency of the Disease

Common.

Treatment (Control)

Spraying should be commenced as early as possible and, if the disease has occurred the previous year, should be started before the spots actually appear.

Summer strength LIME-SULPHUR[1] may be used at this stage, and this has also the advantage of ridding the plants of *mildew*.

If it is late in the season there is danger of discolouring the fruit, the best spray to employ is AMMONIUM POLYSULPHIDE[2] and SOFT SOAP[3], or failing this LIVER OF SULPHUR[4] and SOFT SOAP.

It is preferable however wherever possible to spray before the opening of the flowers, and in bad cases two or three sprayings should be given at intervals.

STRAWBERRY MILDEW

Name *Sphærotheca humuli* Class *Erysiphaceæ*
Order *Ascomycetes*

Plants Attacked

Strawberries, hops and many wild plants, e.g. meadow sweet, agrimony, etc. are attacked by the same species of fungus but, as Salmon has shown, it is a different "strain" and cannot infect the strawberry.

Related Diseases

Gooseberry mildew, vine mildew and other "powdery mildews."

General

The fungus causing this serious and common disease of strawberries is a specialised form of that producing "mouldy hops." The disease may be controlled by similar methods to those employed in the case of the hop (page 553) and it is important to deal with it *before the berries are attacked.*

Occurrence and Symptoms

The first symptom of the disease is the gradual *turning upwards*

[1] See page 612. [2] See page 601. [3] See page 452.
[4] See page 624.

of the edges of the leaves. There are not, as in the case of the hop, conspicuous patches of white on the surfaces of the leaves. The curving of the leaves often continues until the whole of the under surface is exposed. If this be now examined with a hand-glass, a delicate white down is seen spreading over the leaf.

The attack may not happen until late in the season, when the crop has been gathered. It is when it occurs on the young leaves that it is most serious, since the fruit is likely to be attacked and spoilt. The summer spores are produced in great profusion on the down (or mycelium) and the winter stage probably occurs on the old leaves, though it has not often been detected. As stated above, the plants may become infected each year from neighbouring weeds.

Effect on Plant

The plant is weakened, and in serious cases killed by the fungus. If the fruit is attacked it is rendered quite unsaleable.

Frequency of Disease

Common.

Distribution

Widespread.

Treatment (Control)

It is especially important in the case of this disease to keep a careful watch for its first appearance, so that it may be controlled before the fruit is attacked.

The plants are at once sprayed with either:

1. LIVER OF SULPHUR and SOFT SOAP.
2. LIME-SULPHUR (half summer strength), or, best of all, if obtainable,
3. The author also suggests the experimental use of AMMONIUM POLYSULPHIDE and SOFT SOAP. Care must be taken to adjust the quantity so that the leaves are not scorched.

Blowing SULPHUR on the plants with a hand-bellows or sulphurator is also of proved benefit, but cannot be done for some weeks before the fruit is ripe. If the disease occurs after the fruit is picked, advantage has been derived from placing straw and other inflammable materials around the plants, and burning the leaves. The new leaves in the following spring are said to be strong and healthy.

All weeds should be kept off the garden and, as far as possible, the neighbouring ground should also be kept clear.

For scientific data, see page 554.

DISEASES OF THE VINE

593*a*

593*b*

594

593 Vine Mildew (*a*) on leaf, (*b*) on fruit
594 Vine Sclerotinia

chromo-lith Cambridge University Press

CHAPTER 40

Diseases of the Vine

VINE MILDEW

Name *Uncinula spiralis* Class *Erysiphaceæ*
Order *Ascomycetes*

Plants Attacked

Vines.

Related Diseases

Other powdery mildews (hop, gooseberry, apple, etc.).

General

This is a common and very destructive disease of grape vines, and was first noticed at Margate in the year 1845, since when it has spread over the entire globe. Many countries gave up the cultivation of the grape in consequence of the immense amount of damage to the fruit caused by the fungus. This was before the days of spraying. By prompt action it is not difficult to keep the disease in check, as the fungus, in common with the other powdery mildews, is very open to treatment, the fungus threads (or mycelium) being on the surface of the leaf.

The damage is done by the "roots" of the fungus (haustoria) which penetrate the leaf and withdraw the sap from the leaf cells, in this manner finally causing their death.

Occurrence and Symptoms

The fungus appears as whitish patches on the upper surfaces of the leaves, or on the shoots, flowers or fruit. These rapidly increase in size until the whole surface is covered. The fungus later on becomes grey and powdery owing to the formation of millions of "summer" fruit (conidia) which disperse, and infect other plants. Later on, the winter (ascigerous) stage of the fungus is produced among the same threads (mycelium) as minute yellowish bodies, turning brown. These are winter-spore cases, and are able to stand severe frosts and liberate spores which re-infect the plants the following year.

Effect on Plant

1. The young *leaves* are often withered, old leaves become dry and develop brown stains.
2. Attacked *shoots* of young blacken and die, older shoots become discoloured and weakened.
3. *Fruit* usually cracks and dries up, becoming quite useless.

Treatment (Control)

The safest and most successful treatment is the application of FLOWERS OF SULPHUR[1], see page 626, with a hand bellows.

The time of application and the temperature are of importance.

It should be applied

1. Before the flowers open (about a week previous).
2. When in full bloom.
3. About a month later if the fungus is still seen.

During the application (dusting or blowing) the thermometer should stand between 80 and 100° F.

Good results have also been obtained by the use of LIVER OF SULPHUR[2] ($\frac{1}{2}$ oz. to one gallon of water) sprayed on the plants. The author does not recommend this owing to the liability of variation in its composition (see page 624).

VINE SCLEROTINIA

Name *Sclerotinia fuckeliana* Class *Pezizineæ*
Order *Ascomycetes*

Plants Attacked

Vines.

1. General

Occurrence and Symptoms

This disease occurs as a dense, dark greyish, fluffy covering over the trees and fruit, and other portions of the plant.

Countless spores are produced which readily float in the air and infect other portions of the vine. Meanwhile, black portions of the fungus, termed *sclerotia*, are formed in the interior of the plant underneath the part attacked by the mouse-coloured mould.

[1] Some growers have placed sulphur on the hot water pipes but this is too risky to recommend.

[2] See page 624.

These remain in position throughout the winter, and in the following spring produce either "summer" or "winter" fruit, according to weather conditions, etc.

In either case, spores are produced which infect other portions of the plant.

Effect on Plant

Very serious injury is caused by this disease. The fruit, if attacked, is quite destroyed, and the plants do not long survive if prompt measures are not taken to remove infected portions.

Frequency of Disease

The disease is widespread. In this country it frequently attacks grapes grown under glass, the disease requiring a damp atmosphere for its growth.

Treatment (Control)

Adequate ventilation is of great importance as a preventive of attack.

When the disease has appeared, it is recommended to spray with LIVER OF SULPHUR[1], but the author advises an experimental trial of AMMONIUM POLYSULPHIDE[2] and SOFT SOAP[3], as this has proved of great efficiency in other cases.

In any case, infected leaves and fruit *should be at once* removed, as the fungus harbours in the interior of the tissues if these are allowed to remain, and grows out again the following year.

2. Scientific

Conidia

Borne in clusters upon simple or branched hyphæ, forming dense tufts, spherical, 10—12μ.

Ascospores

2 to 3 on black sclerotium, brownish, spores 10—11 × 6—7μ.

[1] See page 624. [2] See page 601. [3] See page 452.

SECTION VIII

FUNGICIDES

SECTION VIII

FUNGICIDES

CHAPTER 41

Introduction

The fungicides at present of practical interest and value are all either

1. COPPER COMPOUNDS, or
2. SULPHUR AND ITS COMPOUNDS.

1. **Copper compounds**

A good many of these have been proposed from time to time, but two only are of importance as far as the fruit grower is concerned. The first of these is

COPPER SULPHATE (BLUESTONE),

which is an excellent and powerful *winter spray* for all fungus diseases which are amenable to treatment. It is much too powerful to use when trees are in leaf. At such times, an insoluble compound of copper, known as

BORDEAUX MIXTURE

is used. It is chiefly valuable as a preventive against infection by fungus spores, the deposit remaining on the leaf for many weeks. Another similar compound is

BURGUNDY MIXTURE,

which is largely used in spraying potatoes.

Copper compounds *cannot be used with soft soap.* This is because the copper is thrown down as a curd by the soap, with which it forms an insoluble compound.

2. **Sulphur and its compounds**

It is advisable to distinguish between those compounds of sulphur *which can, and should be used with soft soap*, and those which cannot, or are not so used. To the first class belong

AMMONIUM POLYSULPHIDE,
LIVER OF SULPHUR,
SODA-SULPHUR.

One great advantage of these fungicides is that they can all be sprayed with an insecticide, such as nicotine, and so be used to "kill two birds with one stone."

The first-named is a recent introduction, but will undoubtedly prove of great value, and will replace Liver of Sulphur, the great disadvantage of which is its liability to variation. By "Soda-sulphur" is meant the substitute for Liver of Sulphur, manufactured with soda instead of potash. It is even less satisfactory, having a greater tendency to scorch. The two remaining fungicides which are used without soap are

SULPHUR itself, and
LIME-SULPHUR.

Sulphur is used by *blowing* or *dusting* it on to the plants, as a fine powder. It is useful for those fungus diseases of which the threads (or *mycelium*) live on the surface of the leaves, etc. These are known as the POWDERY MILDEWS, and include the hop mould, vine mildew, strawberry mildew, etc.

Lime-sulphur is at the present time the most popular all-round fungicide. It is largely used during the dormant season as a cleansing wash, and is thought by some to have valuable insecticidal properties, especially against aphis[1]. It is also employed in place of Bordeaux for spring and summer spraying in the case of varieties of fruit trees which are injured by copper sprays. It is the standard wash to employ against American Gooseberry Mildew. Although it cannot be used with soft soap it has recently been found that the use of *saponin* increases its efficiency.

[1] See for instance Seabrook's *Modern Fruit Growing*, pages 91, 94.

CHAPTER 42

Fungicide Materials

AMMONIUM POLYSULPHIDE

1. General

Employment

This is a comparatively new spraying material and will probably be found to have a wide application. In particular, it should be useful for the spraying of trees or bushes in fruit in place of lime-sulphur, as, unlike the latter, it leaves no deposit on the berries, etc. It has been very successfully used in the case of AMERICAN GOOSEBERRY MILDEW (page 539), and can be employed in any stage without the fruit being marked.

It has the great advantage that it can be used with soft soap which enables it to **penetrate** the fungus. Insecticides may also be used at the same time (e.g. nicotine, quassia, etc.).

Description

The use of ammonium polysulphide as a remedy for fungus diseases, and especially against American gooseberry mildew, originated from researches conducted at Wye college, by Professor Salmon and Dr Eyre. They showed that, used with soft soap, it is a fungicide of great power, and very much superior to liver of sulphur, the only other material for the purpose which could be used in a soap wash.

Growers are advised to experiment with this wash as a substitute for liver of sulphur. Soap and insecticides can be used with it. It must be cautiously applied, as an excess may easily scorch the plants.

Properties

The concentrated material is a dark orange-red liquid, very pungent, and smelling strongly of ammonia. Care should be taken, especially in hot weather, to stand clear of the vapour when handling the strong liquid. It is also very necessary to store in a cool place and in tight packages, and if a can or barrel is opened, it is best to use the whole of it at once if possible. When diluted, it is not unpleasant in use, is harmless, and non-poisonous.

Preparation

As this involves the use of air-tight vessels and the employment of an extremely poisonous gas[1], necessitating skilled scientific control, it is out of the question for the grower to prepare his own material.

Tests

It is not possible for the grower to apply any test for strength or quality—the specific gravity test is worthless in this case. It is therefore very important to purchase from a firm of high standing which is prepared to guarantee their product being prepared according to the standard formula, and of the requisite strength.

The active ingredient is the ammonium polysulphide, and the strength is therefore reckoned on the percentage of this constituent. According to tests made by the author, the "1918" formula solution should contain not less than the following percentages of ingredients:

Ammonia 18·5 per cent.
Sulphur 22·0 " "
as sulphide 9·0 per cent.
as polysulphide 13·0 per cent.

Stronger concentrates than this can however be prepared.

Action on Fungi

Wherever applied under the proper conditions, and with a sufficient amount of soft soap, it appears not only to stop the growth and spread of the disease, but in many cases to actually destroy the fungus itself (the "threads"—*mycelium*—becoming brown and withered). This particularly applies to the "powdery mildews"—American gooseberry mildew, hop mould, apple mildew, strawberry mildew, etc.

Action on Plants

Damage is liable to occur to the leaves of the plant sprayed, and it is well to give a trial application in the case of gooseberries, and especially in regard to other mildews.

Some varieties of gooseberries stand the wash very well, but others are notably susceptible to all sulphur washes.

[1] Even under skilled control, slight leaks of the gas have resulted in serious effects upon the operators.

2. Method of Use

Strength of Spray

There are two formulæ suggested by Wye college conveniently referred to as "A.P.S. 1918" and "A.P.S. 1919." The latter is approximately double as strong as the former.

Two strengths are advised according to whether two applications are given or a single spraying only. The weaker strength applied twice is advised in all cases.

A. FOR DOUBLE SPRAYING (and in all cases of doubt or first trial) per **100 gallons** of spray—**1 gallon** of concentrated ammonium polysulphide ("A.P.S. 1918") or ½ **gallon** ("A.P.S. 1919").

B. FOR A SINGLE SPRAYING (only if previously tried and successful) per **100 gallons** of spray—**2 gallons** of concentrated ammonium polysulphide ("A.P.S. 1918") or **1 gallon** ("A.P.S. 1919").

Soft Soap

In all cases, soft soap *must* be employed with the spray to ensure that the fungus is reached (or penetrated). There should be not less than 4 lbs. of *free soap* (see page 458).

The following will be found a fair guide:

SOFT WATER	**5— 7**	**lbs. soft soap.**
MEDIUM WATER	**8— 9**	,, ,, ,,
HARD WATER	**10—12**	,, ,, ,,

A much better method is to get an idea of the hardness of the water, and make use of the following table:

Hardness of water (see page 460)	Amount of soft soap[1] to use (lbs. per 100 gallons water)
5— 8	5
8—11	6
11—14	7
14—17	7¾
17—20	8½
20—23	9¼
23—26	10
26—30	11

Preparation of Spray

Boil the soft soap with a small bulk of the water in the usual way; dilute to 100 gallons; then add the ammonium polysulphide and stir well.

[1] Of at least 40 per cent. fatty acids (page 452).

The wash should be used at once and not allowed to stand for any length of time.

NOTE. Wooden and iron vessels are suitable, but copper or brass should not be used. The spraying machine and nozzles should be well washed through after use with water (as for lime-sulphur).

When to Spray

In the case of "American Gooseberry Mildew," the first spraying with the "A" formula (1—100) should be given as soon as the mildew is seen and another application made 10—14 days after, *or* the mildew is sprayed once with "B" solution (2—100) as soon as it shows signs of becoming "powdery," as it is more readily killed at this stage than previously.

For other fungus diseases, refer to the detailed descriptions in Section VII.

How to Spray

As for soap (see page 452).

3. Scientific

Chemical Composition

It consists of the sulphide and polysulphides of ammonium, together with some free ammonia, and probably some ammonium thiosulphate.

Material made on the Wye formula ("A.P.S. 1918") contains on an average the following parts per 100:

Ammonia 19·0
Sulphur 24·0
as sulphide 10·5
as polysulphide 13·5.

The "A.P.S. 1919" formula contains about double the percentage of polysulphides.

Properties

Pungent reddish-orange liquid. Readily soluble in water.

In dilute solutions becomes cloudy on standing owing to deposition of sulphur.

As made by the Wye formula ("A.P.S. 1918") the specific gravity is 1·036 at 17° C.

Analysis

The ammonia, sulphide, sulphur and polysulphide sulphur should be determined, and should conform roughly to the above.

BORDEAUX MIXTURE

1. General

Employment

As a spring and summer spray for the treatment of most fungus diseases.

Description

Bordeaux mixture results from treating a solution of copper sulphate with lime. By this means the copper is thrown out of solution in the form of what are known as "*basic sulphates.*"

The exact action of the mixture on the fungus is still a matter of controversy. Either the copper becomes gradually soluble, and so active, by the action of the air[1] (actually by the "carbon dioxide" existing in the atmosphere in small quantities) or the action of the fungus itself upon the Bordeaux renders it soluble and capable of being absorbed by the former[2].

As the name indicates, the preparation was originally used on vines in France. It finds its chief use against the potato blight in this country.

As regards fruit trees, the use of Bordeaux, which was pretty general a few years ago, has rapidly declined in favour of lime-sulphur, owing to the liability of scorching action on the leaves and fruit ("Bordeaux injury"). Certain varieties of trees will not stand even a weak application of copper compounds; not only are the leaves and fruit affected, but the leaves are shed.

A great advantage of Bordeaux mixture properly applied is that a thin continuous film of the material remains on the leaf for long periods after the application, thus ensuring protection from fungus spores.

Bordeaux injury

This is shown:

1. By certain varieties of apples under all conditions.
2. In moist or damp weather.
3. When the wrong kind of spray is used.

[1] The "chemical theory" advocated by Pickering (see *Woburn Reports*).

[2] The "biologic theory" supported amongst others by Professors Barker and Gimmingham (see *Reports of the Fruit and Cider Institute*, Long Ashton).

Amongst the most susceptible of injury are Cox's Orange, Beauty of Bath, Gladstone, Lady Sudeley.

The injury to the leaves shows itself by (1) holes ("shot holes") produced by dead portions of the leaf which drop out. This kind of injury is usually the result of a too heavy or too coarse spraying. (2) The leaves may become yellowed all over, and this is the case when certain susceptible varieties are sprayed. Curiously enough, varieties which in one district are injured appeared to stand the treatment quite well in a different part of the country.

The injury to the fruit takes the form of a corky roughening of the skin (known as "russetting") due to the death of these cells by the action of the copper. In severe cases the fruit cracks open.

Preparation

A. For a small acreage.

Formula.	Copper sulphate ("Bluestone")	**8 lbs.**
	Quicklime (lumps)	**8 lbs.**
	Water	**100 gallons.**

Utensils required.

Two wooden vats to hold 40 gallons and 100 gallons respectively (a barrel with the head out is suitable for the former).

A good strainer of copper gauze.

Method.

1. Place about 20 gallons of water in the barrel and dissolve the copper sulphate therein by wrapping it up in a piece of sacking and suspending it just under the surface of the water. It is best left overnight to dissolve.
2. Place the quicklime—rejecting all but good lumps—in the larger vat, and slake it by adding water in small quantities at a time. When slaked, make up to 80 gallons with water and stir well.

   This is known as milk of lime.
3. Pour the copper sulphate solution slowly into the milk of lime, stirring well till all is added.
4. Use immediately, pouring the well-stirred mixture through a strainer into the spraying machine, or knapsack, which should also have a strainer of its own.

Cautions

a. Use the purest copper sulphate obtainable (98 per cent. purity), not so-called "agricultural bluestone."

b. Freshly burnt lime of high quality is necessary, rejecting any powder (which is "air-slaked" and useless).

c. Stir the slaked lime thoroughly so as to produce a fine "milk."

d. Stir well when adding the copper solution.

e. Never use iron or zinc vessels but only those of wood or copper.

B. For large scale operations.

The same procedure is followed, except that a double platform is advisable, and three vats are then used. On the top stage are placed, side by side, two 50 gallon tubs, each with a tap, so that the liquid can be run into a 100 gallon vat placed on the lower stage. This latter is just high enough to feed with a tap direct into the spraying machine.

The copper sulphate is made up into a "*stock*" *solution* of 100 lbs. to 100 gallons in another vat, and for each mixing 8 gallons are measured out and placed into one of the tubs on the top staging.

Water is now added up to the 50 gallons mark (it is a great convenience if water can be laid on to this stage) and the contents stirred well.

In the other tub the lime is made up as in § 2 above, but 50 gallons of water only are added.

The mixture is now prepared by opening both taps and running the two liquids into the vat beneath (under the two taps it is best to place the strainer). When all is run in and well mixed in the lower vat, it will contain 100 gallons of prepared mixture. This is now fed out through the tap into the spraying machine which should have a fine copper gauze strainer.

Commercial Brands

There are several ready-prepared Bordeaux powders and pastes on the market, but it has been proved beyond doubt that the freshly prepared mixture, made as before described, is superior for spraying fruit to either the powder or the paste.

Of the two, the paste is preferable to use, as it is in a much finer condition, is less likely to cause damage and mixes more easily with the water.

The disadvantage of even the best pastes however is that they have not the adhesive properties of the freshly prepared mixture. On careful trials, it was proved that over half of the copper was soon washed off the trees. Whereas, with the fresh mixture, only about 5 per cent. was lost in the same time.

If however it is not possible for the grower to prepare his own mixture, a good make of paste from a manufacturer of repute should be used.

Tests

If insufficient lime is present in Bordeaux mixture, there will be some free or soluble copper in the wash which is liable to cause grave injury to the plant. The same remark applies of course to the commercial pastes and powders.

In order to test for free copper in the liquid, proceed as follows:

1. Purchase from a druggist an ounce or two of POTASSIUM FERROCYANIDE.
2. Dissolve in water in a medicine bottle.
3. Take a little of the well-settled Bordeaux mixture and place in a white saucer. Add a few drops of the solution from the bottle. If a *chocolate brown colour* is produced there is *free copper* present.

The way to cure a mixture with free copper in solution is to add a little milk of lime to it and stir well.

The test as above may then be again applied.

The test using a piece of bright steel is not sufficiently delicate and should not be relied upon.

Remarks

Mr Spencer Pickering has made a very careful investigation of the chemistry of Bordeaux mixture. As a result he recommended the use of much less lime in the mixture, which would produce more "available copper" and therefore be stronger and more efficient. Unfortunately, the Bordeaux so prepared has not the adhesive properties of the Bordeaux normal mixture and so is liable to be readily washed off the trees. On the whole therefore it is best for the grower to stick to the old and well-tested formula as above.

2. Method of Use

Strength of Spray

See under *preparation* above.

This is the standard strength. For summer spraying and for some of the more susceptible varieties, the spray may be diluted with an equal amount of water.

In the case of the various pastes and powders, the manufacturer's directions should be followed.

For winter spraying, it is best to use copper sulphate, or lime-sulphur at winter strength.

When to Spray

For almost all diseases of fruit, it is best to give two sprayings:

1. When the leaves are just fully expanded—which is generally soon after the fruit has set.
2. A month or five weeks later.

It should be borne in mind that Bordeaux is a *preventive* spray and growers should not wait for signs of the disease on the leaves or other parts of the plant. It is a good plan in the case of some of the more susceptible varieties of apples to give a spraying of Bordeaux first, and to use lime-sulphur at summer strength for the second spray a month or so later.

How to Spray

A type of nozzle must be employed which gives a very fine spray—practically a "fog." This is even more necessary for Bordeaux spraying than for arsenate of lead.

A fine hole should be used, and a high pressure at the pump is essential. There should be no large drops or jets of liquid.

The spray must be sparingly given and should not run off the leaves. Both surfaces of the leaf should be coated equally all over.

In order to reach the high branches, a long lance (preferably of bamboo) is necessary. Most spraying outfits have fittings for extension rods for this purpose.

Knapsack sprayers are useful for the smaller trees and bushes. Suitable hand sprayers are shown on pages 640–645 and petrol driven machines on pages 649–657; while the correct adjustment for spraying nozzles is as figs. 252, 253 on page 635. A sprayer for ground crops is shown on page 648.

3. Scientific

Chemical Composition

Pickering[1] has investigated the composition of Bordeaux mixtures very closely. He finds that, according to the proportion of lime employed, various insoluble basic sulphates are produced. Thus, using lime water, and employing varying proportions of lime, the following are formed:

Lime to copper sulphate	Basic sulphate formed
1 : 6	$4CuOSO_3$
1 : $5\frac{1}{2}$	$5CuOSO_3$
1 : 5	$10CuOSO_3$

Using the proportions of ordinary Bordeaux mixture (equal parts of lime and crystallised copper sulphate) the $10CuOSO_3$ sulphate is chiefly produced, together with calcium sulphate. Other secondary reactions also occur.

Action of Bordeaux

As previously stated, this is still a matter of controversy, and must at present be left for the experts to decide.

Analysis

As the action of Bordeaux depends upon the gradual setting free of copper in a soluble form, and as there is always excess of insoluble copper present, it is not possible to value a sample of paste or powder by its *copper content*, other properties, such as fineness, absence of free copper, or adhering powers being much more important.

Valuation is therefore only possible on an actual experimental basis, under the conditions obtaining in practice.

BURGUNDY MIXTURE

This has been largely used as an alternative to Bordeaux mixture for potato spraying. As far as is at present known, it offers no advantage over Bordeaux as a fruit spray. It is therefore not described in detail here.

Description

Burgundy mixture is similar in most respects to Bordeaux, with the exception that the place of lime is taken by carbonate of soda (washing soda), a usual formula being:

Copper sulphate (bluestone) crystals	10 lbs.
Washing soda crystals (carbonate of soda)	$12\frac{1}{2}$ lbs.
Water to	100 gallons.

[1] 11th Report of the Woburn Experimental Fruit Farm.

The copper sulphate is dissolved in say 70 gallons of water, the washing soda in the remainder, and this is then stirred into the copper solution. Practically all the other directions given under Bordeaux are applicable to Burgundy mixture also.

COPPER SULPHATE

(bluestone)

1. General

Employment

As a winter wash for fruit trees and in the preparation of Bordeaux and Burgundy mixtures.

Description

Copper sulphate is a powerful poison to all fungi. It cannot however be used on trees in leaf, owing to its violent scorching action.

Scorching has been found to occur at a strength of 12 ozs. per 100 gallons of the crystallised copper sulphate. For this reason, insoluble compounds of copper are used upon trees in leaf (see pages 605, 610).

As a winter wash it has given very successful results. Fungus diseases, such as Apple Canker, Black Spot (Scab), and Brown Rot have been eradicated by winter spraying with 10 lb. per 100 gallons. In the case of old and neglected or cankered trees, it is best used some weeks after treatment with caustic soda (see page 413). Some successful growers make a practice of spraying their trees with caustic soda and copper sulphate in this way, every three years.

Properties

It occurs as blue crystals containing about 64 per cent. of true or dry copper sulphate, the rest being water.

It should be free from iron, but usually contains traces of nickel. It is a poisonous substance and should be handled with care. As it is rather troublesome to dissolve, it is best to buy the small crystals or powder.

Remarks

The grower should purchase the pure article only (98 per cent. guaranteed). The so-called "agricultural bluestone" should be avoided.

2. Method of Use

Strength of Spray

For spraying dormant trees only,

4—10 lbs. per 100 gallons[1].

Dissolve in a pailful of water (hot is quicker) and stir into the bulk of the water. Another way is to tie up the crystals in a piece of sacking and suspend just beneath the surface of the liquid. It will *not* mix with soap.

LIME-SULPHUR

1. General

Employment

As a winter and summer wash for all fruit trees, for American Gooseberry Mildew and for fungus diseases generally, especially *powdery mildews*, Apple Scab (Black Spot), etc. Also for Big Bud mite in spring[2]. With regard to its use as an insecticide, see page 430.

Description

Lime-sulphur, sometimes wrongly described as "lime and sulphur" is the name given to the liquid produced by boiling lime and sulphur with water. Both the strength and the composition vary a great deal according to the amount of each ingredient used, the manner of boiling, and the length of time taken in its manufacture. On the exact chemical nature of the constituents of lime-sulphur, scientists are not yet agreed, but it may be taken as a general rule, THAT THE MORE SULPHUR CONTAINED IN SOLUTION IN THE WASH THE MORE VALUABLE IT IS FOR SPRAYING PURPOSES against fungus diseases (see however below).

Formerly many growers boiled their own lime-sulphur, but this practice is rightly dying out, as the home-boiled substance is much less efficient, and much more wasteful of sulphur than the

[1] Copper sulphate has been used at a strength of 100 lbs. per 100 gallons without causing injury (see *Wye Journal*, No. 20, p. 405).

[2] Professor Lees. See also note on page 371 and fig. 246.

high grade factory produced article. This is because it is not possible, without producing large amounts of wasteful residues, to boil high-strength lime-sulphur in the ordinary manner.

When weaker solutions are made, much of the sulphur is used up in the formation of a useless substance called *thiosulphate*, which is only produced in small quantities in the stronger liquids.

The active substance in lime-sulphur is sulphur, which is combined with the lime, forming substances known as *sulphides*.

A good deal of the sulphur may be in solution and not combined with the lime, but it is usually taken for granted that substances termed POLYSULPHIDES are produced. It can now be taken as definitely established[1] that these polysulphides form the active ingredients in the wash. Besides destroying any germinating spores, these substances, when exposed to the air, deposit sulphur in a fine form, and in this way probably also protect the leaf against further fungus attack.

Preparation

For the boiling of lime-sulphur, an iron pot, mounted in brickwork with an iron grate underneath, is suitable. It is better to have a mechanical stirring gear, but for small quantities this is not essential.

The lime, which should be in lumps and not powder, is placed in the pot, and slaked with a little water first, then the bulk of the water added. The fire is now made and the contents brought to a boil, and kept gently boiling while the sulphur is added. This should be in small quantities at a time. The boiling should continue about an hour after the addition of the last of the sulphur. Water should be added from time to time to make up the loss through evaporation. The finished liquor is tested and used as described on page 619.

Quantities

A suitable quantity to boil is 100 gallons, the charge being

Lime	$1\frac{1}{2}$ cwt.
Sulphur	2 „
Water to	100 gallons.

If the lime is extra good, less may be used.

[1] See Eyre, Salmon and Wormald, *Journal of Agricultural Science*, Vol. IX., Sep. 1919, p. 283.

Commercial Brands

High grade lime-sulphur is at present sold by various makers on its *specific gravity*, i.e. its relative weight compared with water. The agreed standard among manufacturers is 1·3 specific gravity. This means that each gallon of the concentrated liquor weighs 13 lbs. This may also be described as 33 degrees Beaumé or 60 degrees Twaddell.

Lower grades are also marketed, but it is not economical or advisable to use them.

It may here be pointed out that the specific gravity, although a good indication of strength, is not, in itself, a final guarantee of the efficiency of a brand. It is quite possible to obtain a S.G. of 1·3 with the use of only a relatively small proportion of sulphur.

Growers are therefore advised to enquire the percentage of *poly-sulphide-sulphur* present in a brand as well as the specific gravity, before placing their orders.

Action

Lime-sulphur appears to have a three-fold action when used for spraying trees. Its *caustic* properties (due probably to the *sulphides*) are responsible for its cleansing action on the bark of the tree. In the second place, fungi and possibly fungus spores are killed at once by these ingredients, while its third action is a preventive one, due to the deposition of the sulphur in fine particles[1] on the leaf. This probably prevents the fungus spores germinating.

2. Method of Use

Strength of Spray

For **winter spraying** of trees in a dormant state, the usual strength is **5 gallons concentrated lime-sulphur (1·3 specific gravity) per 100 gallons of wash** (or 1 in 20).

In the case of very neglected trees, and to remove moss and lichen, a quarter to half as much again has been employed with benefit.

For **summer spraying, 1½ gallons of concentrate (1·3 specific gravity) per 100 gallons of wash** (or 1 in 60), may be regarded as FULL SUMMER STRENGTH. Whether this can be safely used depends upon the VARIETY OF TREE and also, to some degree, on weather conditions. One half to one quarter this strength is sometimes advised (see under description of diseases, Section VII).

[1] Probably by the splitting up of the "polysulphides."

Preparation of Spray

There are two ways in which the spray may be prepared. The correct amount of the strong lime-sulphur can be measured out and stirred into the bulk of the water. Another way which may

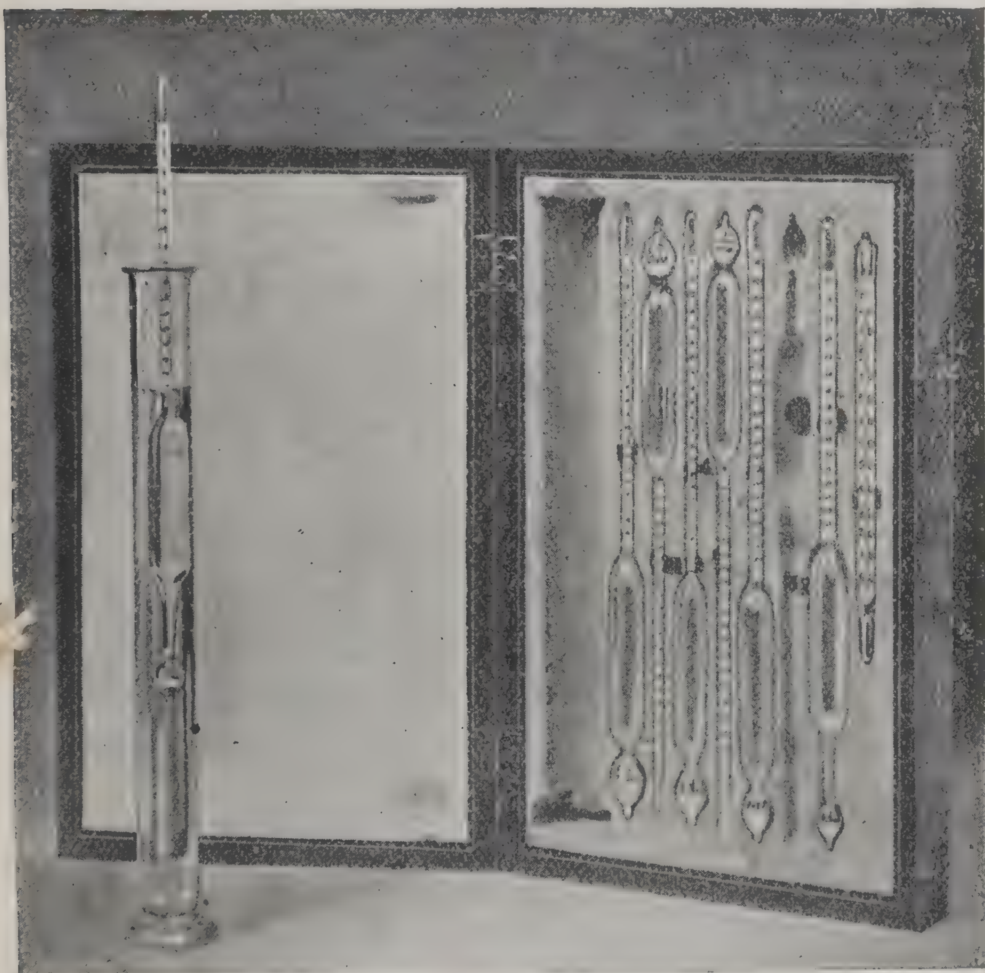


Fig. 243. Set of hydrometers for liquids of various specific gravities, with thermometer.

be used (and which must be employed in the case of "home-boiled" lime-sulphur) is to use a simple instrument called a *hydrometer*. (The accompanying figure (243) shows a case of hydrometers and the method of use). For careful work it is best to use the hydrometer for checking the strong liquid (as bought or made)

and then to measure out the correct quantity. This is because it is not an easy matter to use the ordinary kind of hydrometer accurately with very weak solutions.

How to use the hydrometer

The hydrometer is simply a float made of a glass bulb and weighted with mercury or lead, and having a stem with marks

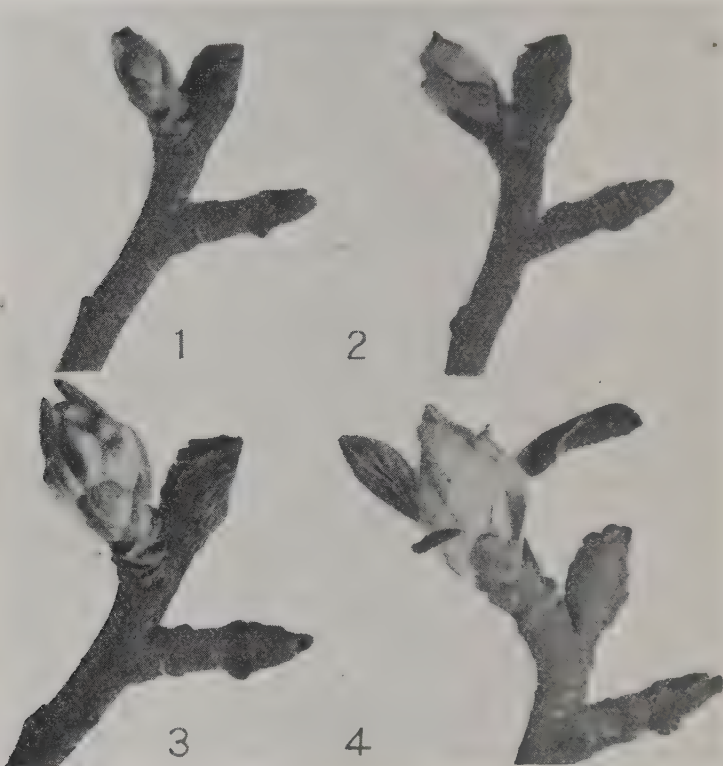


Fig. 244. Apple—Cox's Orange Pippin. Various stages of development of same bud. Full winter strength lime-sulphur is perfectly safe up to stage 3 and did no ultimate harm after careful trials of spraying at stage 4.

upon it at equal distances. According to the relative weight or *density* of the liquid (i.e. its specific gravity) the hydrometer sinks either higher or lower, and more or less of the stem is immersed. The reading of the specific gravity is taken at a point on the stem level with the surface of the water.

This should be read with the eye on a level with the surface of the liquid, which is best placed in a glass cylinder on a table.

There are three scales of measurement in common use on hydrometers:

Actual Specific Gravity (water = 1·000),
Beaumé (water = 0),
Twaddell (water = 0).

The following table shows how the scales correspond with each other:

Twaddell	Beaumé	Specific gravity	Twaddell	Beaumé	Specific gravity	Twaddell	Beaumé	Specific gravity
0	0	1·000	21	13·6	1·105	44	26·0	1·220
1	0·7	1·005	21·6	14·0	1·108	45	26·4	1·225
1·4	1·0	1·007	22	14·2	1·110	46	26·9	1·230
2	1·4	1·010	23	14·9	1·115	46·2	27·0	1·231
2·8	2·0	1·014	23·2	15·0	1·116	47	27·4	1·235
3	2·1	1·015	24	15·4	1·120	48	27·9	1·240
4	2·7	1·020	25	16·0	1·125	48·2	28·0	1·241
4·4	3·0	1·022	26	16·5	1·130	49	28·4	1·245
5	3·4	1·025	26·8	17·0	1·134	50	28·8	1·250
5·8	4·0	1·029	27	17·1	1·135	50·4	29·0	1·252
6	4·1	1·030	28	17·7	1·140	51	29·3	1·255
7	4·7	1·035	28·4	18·0	1·142	52	29·7	1·260
7·4	5·0	1·037	29	18·3	1·145	52·6	30·0	1·263
8	5·4	1·040	30	18·8	1·150	53	30·2	1·265
9	6·0	1·045	30·4	19·0	1·152	54	30·6	1·270
10	6·7	1·050	31	19·3	1·155	54·8	31·0	1·274
10·2	7·0	1·052	32	19·8	1·160	55	31·1	1·275
11	7·4	1·055	32·4	20·0	1·162	56	31·5	1·280
12	8·0	1·060	33	20·3	1·165	57	32·0	1·285
13	8·7	1·065	34	20·9	1·170	58	32·4	1·290
13·4	9·0	1·067	34·2	21·0	1·171	59	32·8	1·295
14	9·4	1·070	35	21·4	1·175	59·4	33·0	1·297
15	10·0	1·075	36	22·0	1·180	60	33·3	1·300
16	10·6	1·080	37	22·5	1·185	61	33·7	1·305
16·6	11·0	1·083	38	23·0	1·190	61·6	34·0	1·308
17	11·2	1·085	39	23·5	1·195	62	34·2	1·310
18	11·9	1·090	40	24·0	1·200	63	34·6	1·315
18·2	12·0	1·091	41	24·5	1·205	64	35·0	1·320
19	12·4	1·095	42	25·0	1·210	65	35·4	1·325
20	13·0	1·100	43	25·5	1·215	66	35·8	1·330

Strength required using the hydrometer

The full WINTER STRENGTH of 1 in 20 (5 gallons to 100) using high grade lime-sulphur of 1·3 specific gravity is equal to the following on the hydrometer:

Specific gravity 1·015
Beaumé 2·1 degrees
Twaddell 3 „

Fig. 245. Pear—various stages of development of same bud. Full winter strength lime-sulphur was tried in all stages shown and though it caused scorching in stages 3 and 4, there was no ultimate injury.

The full SUMMER STRENGTH of 1 in 60 ($1\frac{1}{2}$ gallons to 100) under the same conditions is:

Specific gravity 1·005
Beaumé 0·7 degrees
Twaddell 1 „

How to dilute home-boiled lime-sulphur

1. Cool[1] a sample of the settled finished liquid (it should be quite clear). Place in a glass vessel and dip the hydrometer into it.
2. Take the reading in the usual manner, previously described, and according to this figure make the correct quantity up to 100 gallons with water as under:

Amount of lime-sulphur (home-boiled) of various specific gravities required for 100 gallons of wash

Specific gravity	Degrees Twaddell	Degrees Beaumé	For full winter strength	For full summer strength
1·25	50	29	6 galls	16 pints
1·24	48	28	6¼	17
1·23	46	27	6½	17½
1·22	44	26	6¾	18
1·21	42	25	7¼	19
1·20	40	24	7½	20
1·19	38	23	8	21
1·18	36	22	8½	22
1·17	34	20	8¾	23½
1·16	32	20	9½	25
1·15	30	19	10	27
1·14	28	17¾	10¾	29
1·13	26	16½	11½	31
1·12	24	15½	12½	33
1·11	22	14	13¾	36½
1·10	20	13	15	40

It should be pointed out that different boils will vary in efficiency according to the percentage of the different ingredients. As previously mentioned the high strength factory product when diluted to the same specific gravity as a home-boiled lime-sulphur will have much greater working strength.

Use of Saponin

In order to increase the wetting action or *penetration* of lime-sulphur, especially for summer use, it is advised to use SAPONIN

[1] It should be cooled to 60° F. (15·5° C.), i.e. about the temperature of an ordinary living room.

with it. The commercial preparation[1] should preferably be employed, using 1—2 gallons to 100 gallons of the made-up wash (equivalent to 0·05 to 0·1 per cent. of pure saponin).

When to Spray

A good deal of difference of opinion exists as to the best time to apply lime-sulphur in the dormant state of the trees. The balance of evidence is in favour of as late a use as possible in the early

Fig. 246. Black currant, showing development of buds. The best time to spray with lime-sulphur for big bud mite is when shoot is at stage 6. Full winter strength should be used, or even stronger (6 or 8 gallons to 100 gallons). See note on page 371.

spring. The author has made many experiments as to the effect of applying the winter strength lime-sulphur during the opening of the buds, and finds that, although severe scorching of the petals of the opening blossoms may occur, no damage is done to the essential parts of the flower (see Chapter 4), and the fruit develops in the normal way.

[1] Sold by the Yalding Manufacturing Co., Ltd., Yalding, Kent. See page 449.

This may seem drastic treatment to many, and the author does not advise such late spraying in all cases, as it is easy to overstep the safe period and so cause damage. The following photographs

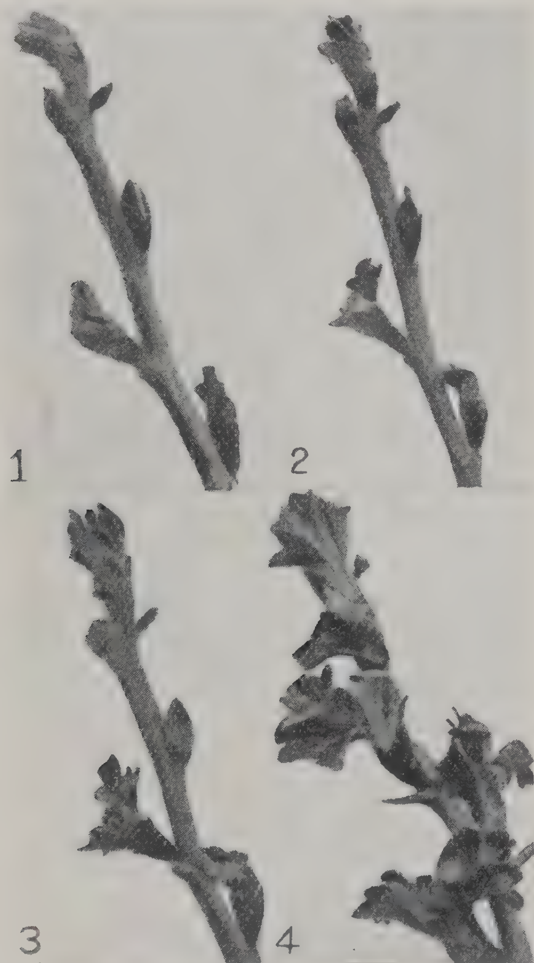


Fig. 247. Gooseberry—stages of shoot development. Spray for American gooseberry mildew immediately first signs of fungus are seen.

show what may be taken as quite safe stages of the opening buds in which to spray at the winter strength in the case of various fruits. In the case of big bud disease on black currants, the plants should only be sprayed at the stage specified (fig. 246, stage 6).

How to Spray

For winter spraying of trees without foliage a high pressure and a small cone of spray are best. If the spray is too much spread out and too misty, a good deal of waste is unavoidable.

A windy day is very unsuitable for spraying as only one side of the trees will be wet.

The spray has a smarting action on sensitive skins and especially on the eyes. The men should therefore be PROTECTED by the use of goggles for the eyes and rubber gloves, and only old clothes should be worn, or overalls used, while oil or fat rubbed well into the skin will prevent the face smarting.

Copper vessels are unsuitable for handling the spray—iron and wood are unaffected. The spray machines after use should be well rinsed through with water, otherwise the brass nozzles and connections are liable to become corroded.

Quantity of Spray Used

1. WINTER AND EARLY SPRING WASHING.

The following are, in the author's experience, average figures which may be taken as a fair guide:

Spread of trees, feet	Amount of diluted spray per 100 trees	Amount of concentrated lime-sulphur (1·3 S.G.)[1]
7	150 gallons	7½ gallons
10	200 ,,	10 ,,
15	350 ,,	17½ ,,
20	530 ,,	26½ ,,
25	800 ,,	42½ ,,
30	1150 ,,	57½ ,,
35	1600 ,,	80 ,,
40	2100 ,,	105 ,,

To find the quantities per acre, multiply the above figures by the following factors; according to the distance apart:

6 ft, 12·1; 10 ft, 4·35; 12 ft, 3·02; 15 ft, 1·93; 18 ft, 1·34; 20 ft, 1·08; 24 ft, 0·75; 30 ft, 0·48; 40 ft, 0·28.

[1] Using full winter strength (1 in 20).

2. Summer spraying.

The amount is variable, according to the leafage. The following is therefore an indication only and represents average results:

Spread of trees, feet	Amount of diluted spray per 100 trees	Amount of concentrated lime-sulphur (1·3 s.g.)[1]
7	225 gallons	$3\frac{3}{4}$ gallons
10	300 ,,	5 ,,
15	520 ,,	$8\frac{1}{2}$,,
20	800 ,,	$13\frac{1}{4}$,,
25	1250 ,,	21 ,,
30	1700 ,,	$28\frac{1}{4}$,,
35	2450 ,,	41 ,,
40	3000 ,,	50 ,,

To find amount required per acre, use figures as above.

3. Scientific

Chemical Composition

This is a matter of some dispute at the present time. While the general opinion is that polysulphides are produced there is evidence to show that the sulphur may be in *physical solution* only, being dissolved in a solution of di-sulphide and thiosulphate with a little hydroxyhydrosulphide, sulphates and sulphites[2]. It is certain that the sulphur is very loosely held and is easily deposited by the action of the air. In any case, it may be taken as proved that it is sulphur in this condition which is the active ingredient. Assuming the higher sulphides are produced, the following are the chief variations in commercial products:

The polysulphide sulphur varies from about 15 to 25 per cent. in high grade products of specific gravity 1·3, while it is very much lower in the case of home-boils.

The sulphide sulphur does not vary much, being about 3 to 4 per cent. in factory and home-boiled products.

The thiosulphate sulphur, which is practically useless as a spraying ingredient, is small in the factory-boiled product, being as a rule not over 2 to 3 per cent. In the case of home-boils, it frequently reaches high proportions, thus in many cases over a quarter of the total sulphur present exists as thiosulphate.

[1] Using full summer strength, e.g. 1 in 60.

[2] A. A. Ramsay, Dept. of Agriculture, *N. S. Wales Bulletin*, 15, 1915.

Analysis

There are several methods advised, and the analyst is referred to the original paper:

"Tartar—Chemical Investigations in the Lime-Sulphur Spray": *Oregon Agr. Coll. Exp. Station Bulletin*, March 1914.

LIVER OF SULPHUR

1. General

Employment

For general spraying against fungus diseases, usually with soft soap. It is also used as an insecticide for red-spider (see page 376).

Description

Liver of sulphur, being manufactured in a somewhat crude manner, and being also very liable to change on keeping and on exposure to air, is a somewhat indefinite substance. In many ways it is at present *very unsatisfactory* for spraying purposes. As ordinarily prepared it has been shown by Professor Salmon to be ineffective against mildews, except when used in such quantities as to cause injury to the foliage. There is no doubt that it has, in the past, caused severe scorching to foliage, especially in the case of hops, when used in the proportions commonly recommended. It is therefore necessary to be VERY CAUTIOUS in using it, and it is best, in all cases, to make a trial at the strength at which it is intended to employ it.

Properties

Liver of sulphur is a mixture of sulphides (mostly polysulphides) of potash together with other substances (see page 431) and is liable to contain qualities of potash as carbonate or caustic. It is not uniform in composition but varies according to the manner of manufacture. It is a dark brown or greenish substance, with an unpleasant sulphurous odour, and should be entirely dissolved by water giving a fairly clear solution. Recently large quantities of so-called liver of sulphur have been prepared with soda[1] in place of potash. Growers should *insist upon a guarantee* of its preparation from pure potash.

[1] See *soda-sulphur*, page 626.

Preparation

It is manufactured by gently heating together sulphur and carbonate of potash in a closed vessel. The temperature and the proportions used of each ingredient have a great influence on its final composition.

2. Method of Use

Strength of Spray

The quantity generally advised is from

2—3 lbs.[1] per 100 gallons of wash.

It is best used with SOFT SOAP sufficient to produce a good lather in the spray.

Preparation of Spray

The correct amount of liver of sulphur is weighed out, dissolved in half a pailful of water, and well stirred into the bulk of the soapy liquid.

When to Spray

See under description of diseases (Section VII).

How to Spray

As for soap (page 455).

Remarks

The author advises the trial of ammonium polysulphide (with soap) or lime-sulphur (without soap) in place of liver of sulphur, as at present manufactured.

3. Scientific

Chemical Composition

Liver of sulphur is often *misnamed potassium sulphide*[2]. It is a complex, and by no means uniform, mixture of various polysulphides of potash, together with varying, but often large, amounts of sulphate and thiosulphate.

Analysis

It should be valued upon its content o *sulphide-sulphur*. Sulphates and thiosulphates are harmless to the plant, but caustic potash or carbonate is a source of danger. *Soda* should be absent.

[1] See caution on page 624.

[2] See Board of Agriculture Leaflets 133, 185, 195, etc.

SODA-SULPHUR

This is a newly coined name which may conveniently be used for *liver of sulphur* prepared with carbonate of soda in place of potash.

It has much the same composition and action as the other compound (see page 624) but is more liable, if anything, to scorch the leaves. In the author's opinion, neither of these substances is, as at present manufactured, sufficiently safe to use, if efficient proportions are to be employed against fungus diseases. For use with soap, a trial with ammonium polysulphide[1] is advised, and where soap is not required, lime-sulphur[2] is of proved efficiency.

SULPHUR

1. General

Employment

For dusting or blowing on to plants affected with fungus diseases, especially the *powdery mildews* (hop, vine, etc.). Also in the manufacture of lime-sulphur.

Description

Sulphur exists in commerce in several forms. There is the crude or *rock* sulphur, most of which comes from the mines of Sicily. This is usually classed in three grades. *Roll* sulphur or brimstone represents the rock sulphur, refined by melting and straining and cast into sticks, while the highest grade is known as *flowers of sulphur*. This is produced by vaporising or "subliming" the sulphur which solidifies in a very fine state.

In addition to the natural product, sulphur is now recovered in various industries, and is known in this form as "recovered sulphur."

One of the forms in which recovered sulphur may be obtained is as "precipitated sulphur." Although in an exceedingly fine state it usually contains only a relatively low percentage of sulphur and this should be taken into account when purchasing.

[1] See page 601. [2] See page 612.

Commercial Brands

The only suitable brand for this purpose is the finest flowers of sulphur. The "precipitated sulphur" has been successfully employed but it should be valued upon the percentage of free sulphur contained in it.

Action

It has been suggested that the action of sulphur is due either to sulphur dioxide (the suffocating gas formed on burning sulphur). or sulphuretted hydrogen (the gas emitted from rotten eggs). It is however almost certainly neither of these, but the sulphur vapour itself which is responsible for its action on fungi.

On plants, sulphur has a distinct stimulating action. In the case of hops, the growth of the bine is increased and it is for this reason that a final dusting with sulphur, just as the burr forms, is valuable in hop cultivation.

2. Method of Use

How to Apply

On a large scale, the sulphur is blown on to the hops by a special machine known as a sulphurator (see page 659). Care should be taken to avoid getting the dust into the eyes; goggles may be worn as a preventive. Other mildews, on strawberries, vines, etc., should be treated in a similar manner using hand sulphurators along strawberry rows and an instrument of the syringe type for grapes under glass.

When to Apply

Sulphur should be applied as soon as any sign of the "mould" is seen on the leaves, or if the disease is known to be in the district, it is well not to wait for its appearance.

Many growers "sulphur" their hops as a standard practice, near the end of the season. This is for its stimulating effect on the hop and to prevent any possibility of mould attacking the cone (or burr).

3. Scientific

Chemical Composition

Sulphur is a chemical element, represented by the symbol S, atomic weight = 32.

Properties

Sulphur as usually found is a light yellow solid, nearly insoluble in water, capable of being evaporated or "sublimed" with heat.

It dissolves readily in *carbon bisulphide*.

Analysis

The physical condition, especially the degree of fineness of the particles, should be noted as well as its chemical purity. The percentage of *free sulphur* should be determined.

PART III

SPRAYING IN THEORY AND PRACTICE

SECTION IX

SPRAYING APPLIANCES AND METHODS

SECTION IX

SPRAYING APPLIANCES AND METHODS

CHAPTER 43

Introduction

There are several important requirements to be taken into account in the selection of spraying appliances and machinery. Of these the chief are:

A. A nozzle of suitable and efficient construction.

B. The provision of adequate pressure to produce the required type of spray, and to reach as high as necessary.

C. A type of machine suited to the size and conditions of the plantation to be sprayed.

A. The Nozzle

Since most machines will be called upon to spray several different materials, it is essential to have a nozzle supplied which can be adapted for each spray and for all conditions of work. Such requirements are fulfilled in the modern ADJUSTABLE NOZZLE. The nozzle shown in figs. 257, 258 is not adjustable and is only suitable when very fine misty sprays are required. A nozzle of the adjustable type consists of the following parts (see figs. 248, 249):

(*a*) The stem or body.

(*b*) A cap bored with two oblique holes to give a circular motion to the liquid.

(*c*) A collar of conical shape which is adjustable by screwing up or down on the stem, and so controlling the amount of liquid passing through.

(*d*) A locknut, with rubber packing ring for clamping the collar (*c*) in any desired position.

(*e*) An outside cap into which fit various removable steel discs, bored with different sized holes.

USE.

1. To obtain *powerful but relatively coarse sprays*, the collar (*c*) is screwed almost to the top of the stem, and there locked. The amount of liquid issuing in the spray is controlled by the size of disc used.

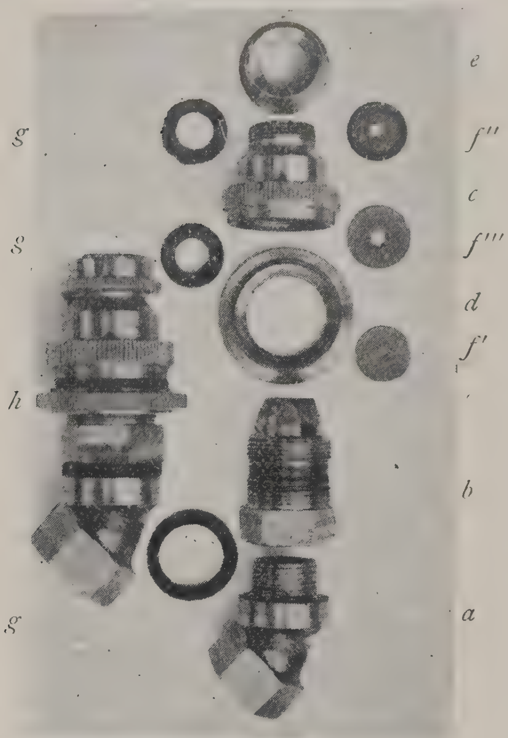


Fig. 248. "Mistifier junior[1]" adjustable nozzle. *a—e*, see in text. *f′*, *f″*, *f‴*, varying size disc jets. *g*, washers. *h*, complete nozzle (screwed down for fine spraying).

Such a type of spray is generally regarded as suitable for spraying aphides or caterpillars with a CONTACT wash. Being relatively powerful, many of the aphides are "hit" and some of the larger ones dislodged by the force of the spray. It is also required when reaching up to the top branches of high trees. Since this adjustment of the nozzle produces a narrow cone of spray, it is more suitable when it is wished to concentrate the spray upon a small portion—such as the bare branch of a tree, etc. For this reason, it is probably the best adjustment for all winter spraying, such as LIME-SULPHUR, CAUSTIC ALKALI, etc.

Although a special form of nozzle ("seneca" nozzle) has been introduced for LIME spraying (see fig. 254), this adjustment of the standard nozzle is very suitable, provided that the lime liquid has been properly STRAINED. The advantage of the seneca nozzle is that it can be rapidly reversed in case of blocking.

2. To adjust the nozzle for *fine misty sprays*, the collar (*c*) is screwed down as far as it will go and locked there in position by means of the nut.

This has the effect of spreading out the spray and of rendering it very fine, especially when a small disc is used.

[1] Manufactured by Messrs Drake and Fletcher, Maidstone.

This class of spray is essential for ARSENATE OF LEAD and other poison washes for caterpillars, for BORDEAUX MIXTURE, for summer spraying of LIME-SULPHUR, and for hops early in the season.

For other purposes an intermediate position of the collar may be used to produce a spray of medium fineness.

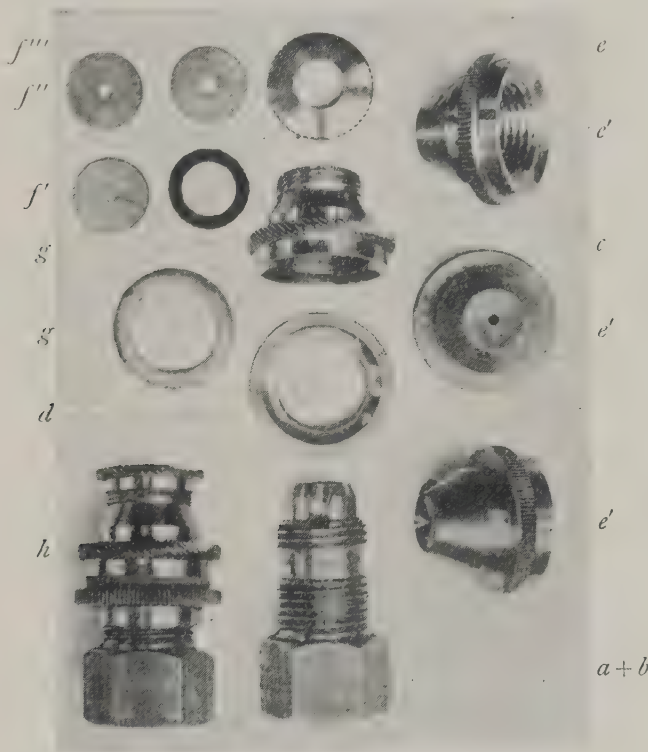


Fig. 249. "Multi-spray[1]" adjustable nozzle. *a—e*, see in text. *e'*, large cap-form jets. *f'*, *f''*, *f'''*, various size discs. *g*, washers. *h*, complete nozzle (screwed down for fine spraying).

B. Adequate Pressure

This is essential in successful spraying. It is particularly necessary when the nozzle is adjusted for producing a *fine misty spray*. Without adequate pressure the liquid cannot be properly broken up or "atomised." This is the great advantage of using *power spraying machines* wherever possible. Such machines produce uniform high pressures, and are

[1] Manufactured by Messrs Weeks, Maidstone.

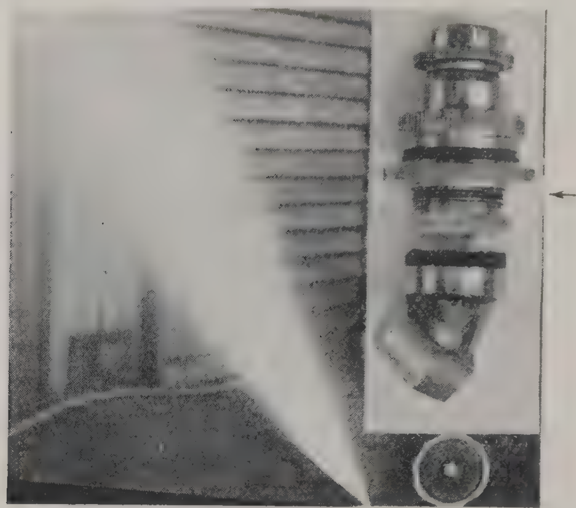


Fig. 250. Collar of nozzle screwed up, using a large disc opening. This adjustment gives a powerful spray reaching to a considerable height, but relatively coarse.

Fig. 251. Adjustment as in fig. 250 but with a fine disc opening giving a narrow angle or cone of spray, powerful but relatively coarse.

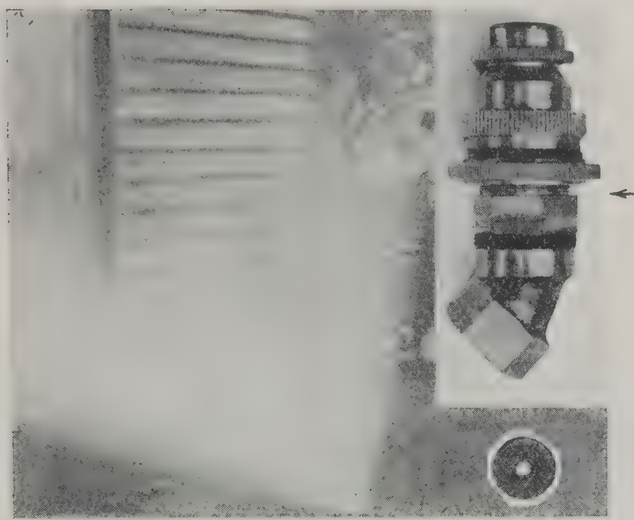


Fig. 252. Collar of nozzle screwed fully down. Disc opening large. This gives a very wide cone or angle of spray relatively fine and misty, but with little carrying power.

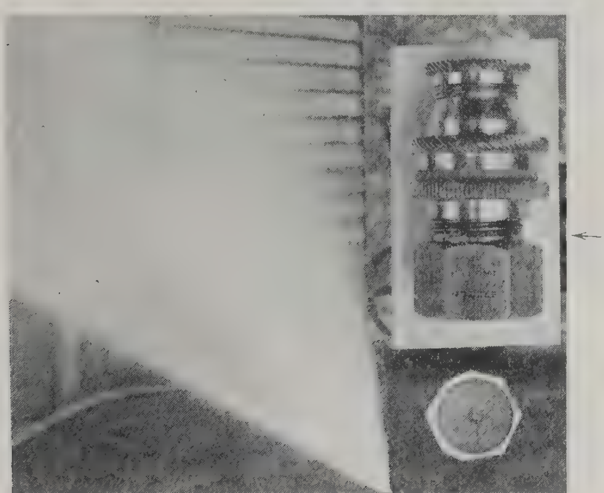


Fig. 253. Adjustment as in fig. 252 but disc opening very small. The cone or angle of spray is narrower but a very fine misty spray is produced.

independent of the fatigue of the workmen. A great deal of failure in spraying is undoubtedly traced to lack of adequate pressure on the pump. The figures (255 and 256) show the coarseness of the spray produced with different adjustments of the nozzle when the power is inadequate.

C. A suitable type of machine.

Various forms of machines will be described in the following chapter. It is only necessary here to point out that it is better for a grower to ave a machine of a larger type than he could manage with, than the

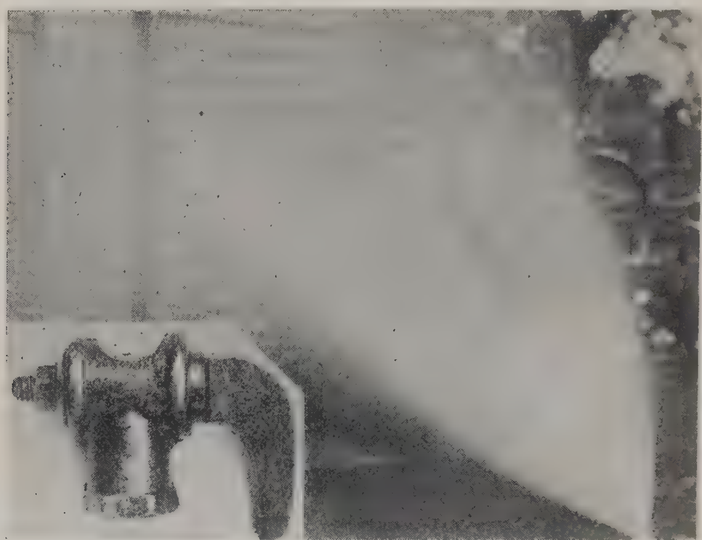


Fig. 254. "Seneca" nozzle for lime spraying.

reverse to be the case. Wherever a plantation exceeds say 20 acres, a power plant of some description will pay to instal, and will give far more efficient service than any other kind of hand or "traction" sprayer. An exception to this is in the case of the first few years of a freshly planted orchard, when the work can be done quite successfully with hand sprayers.

Other considerations in regard to spraying appliances are:

1. The pump and tank should be made of SUITABLE MATERIALS.
2. There should be an EFFICIENT AGITATOR to keep the spray liquid properly mixed.

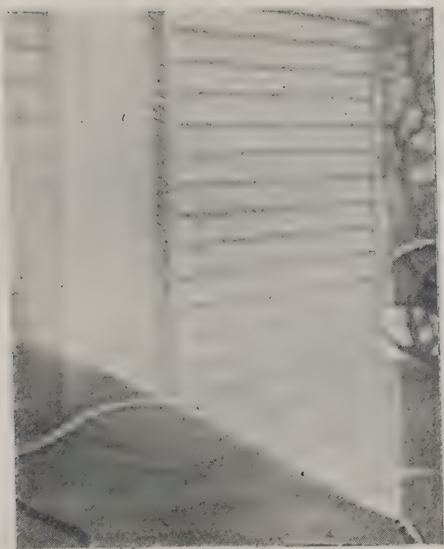


Fig. 255. Nozzle with same adjustment as fig. 250 but with a low pump pressure. Showing coarseness of spray.

Fig. 256. Nozzle with same adjustment as fig. 252 but with a low pump pressure. Showing coarseness of spray.

Fig. 257. "Mistry" nozzle for producing a fine misty spray, not adjustable. *a*, Body and cap with oblique holes. *b*, Disc, with fine jet opening. *c*, Cap for screwing jet in position. *d*, Complete nozzle.

Fig. 258. The "mistry" nozzle in action, showing the fine character of the spray produced.

3. A suitable AIR CHAMBER should be provided to keep the pressure steady.
4. The VALVES of the pump should be of an efficient non-choking type.
5. The pump should be capable of being DISMANTLED rapidly and easily in case of a breakdown.
6. The parts should be readily REPLACEABLE and of a standard pattern.
7. It should be possible to readily renew the PACKING of the piston, glands, etc.

1. Probably brass, bronze, or copper are the most suitable all-round materials for spray pumps and tanks. Nozzles should be of a heavy brass, as iron corrodes very readily. For lime-sulphur, which attacks brass and copper though not very seriously, wooden tanks are the best, and these are also suitable for Bordeaux. (Lime-sulphur has no effect on iron.) Lead-coated iron plate is also suitable for most materials. In any case, the sprayer must be well rinsed out after use and properly looked after when not in service.

2. An agitator for the tank is necessary for spraying with lead arsenate, Bordeaux, and similar washes. It should work automatically off some part of the gear and not require operating separately.

3. The size of the air chamber is important. If large, a steady pressure can be much more easily obtained. This applies to hand pumps; power pumps are usually provided with suitable air chambers.

4. Of the different kinds of valves, poppet, swing, check, ball, etc., the one which gives the most satisfaction is the ball valve. The action of the liquid tends to rotate the ball and so produce even wear. Trouble is however given with sprays which contain *insufficient soap*, but this applies more or less to all types of valves.

5. There will be occasions when it is necessary to examine the valves or other working parts of the pump and these should be readily accessible, otherwise much time will be wasted probably at the very period when it is most valuable.

6. It is well only to purchase a machine of which the parts are of standard pattern and can be replaced at once. For this reason, foreign pumps should on no account be bought unless it is certain that spare parts are stocked in this country and readily obtainable.

7. Stuffing boxes will require frequent re-packing and should be readily accessible.

CHAPTER 44

Types of Spraying Machinery

1. Syringe Sprayers

These are in the form of a garden syringe, with rose cap and also spraying nozzles. They are usually made with a ball valve for filling the syringe by suction. They represent the smallest type of sprayer, and are only suitable for small private gardens or greenhouses. The spray or "atomisation" obtained is fairly fine provided that plenty of pressure is given. It becomes very tedious in use after a short time (fig. 259).

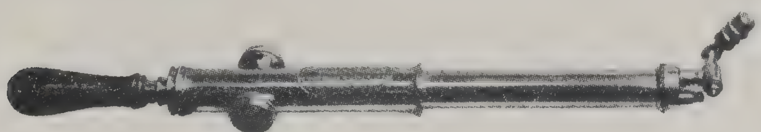


Fig. 259.

Fig. 260[1].

2. Pneumatic Hand Sprayer

This is a useful type for greenhouse work. The air pressure is obtained by means of an ordinary bicycle pump, and the sprayer can then be operated by pressing the thumb lever (fig. 260).

[1] Supplied by Messrs Weeks, Maidstone.

3. Bucket Pumps

These are also suitable for work in a small garden. In some patterns there is a rest provided for the foot and the pump is placed inside the bucket, the plunger being then operated by one hand while with the other the spray is directed. The constant moving of the bucket to fresh positions makes it unsuitable for any but small jobs.

Fig. 261 shows a very compact self-contained outfit marketed by an American company[1]. In this pattern an efficient agitator is worked with the pump handle, and the pump is secured to the bucket by means of wing nuts. Price about £6 complete.

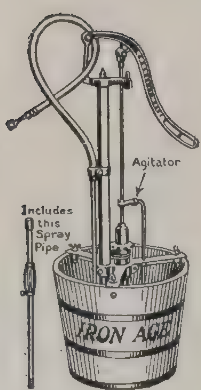


Fig. 261.

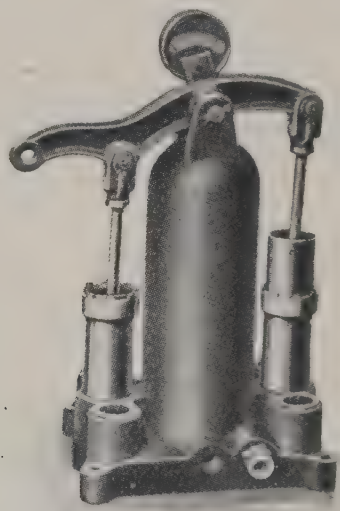


Fig. 262.

4. Knapsack Sprayers

These are very handy for young fruit trees and for small plantations and experimental purposes. They are bean-shaped and designed to carry on the back with shoulder straps, one hand being used to work the pump and the other directing the spray. Their capacity is about three gallons. There are two types, the internal type fitted with rubber valves and diaphragms (like the original "Vermorel" pattern, fig. 263), and an external pump pattern with

[1] The Bateman Manufacturing Company, Grenloch, N.J., U.S.A.

metal valves, fig. 264. The latter type is probably the more suitable for all round work. Price about £4.

Fig. 263.

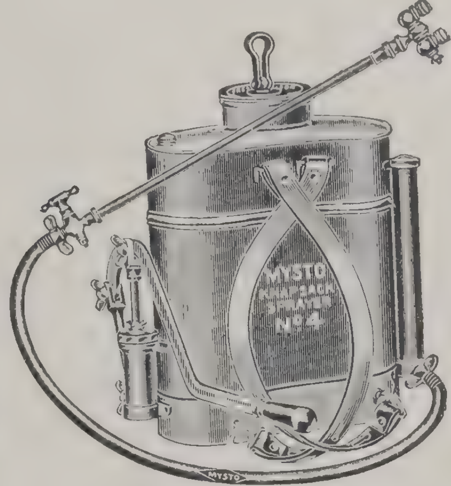


Fig. 264[1].

5. Automatic Sprayers

These are small compressed air sprayers, consisting of steel cylinders provided with an air pump and pressure gauge. The liquid is run in and the cylinders sealed up and charged with air to the desired pressure by means of the pump. The sprayer is then carried round to wherever required and the liquid sprayed by opening the tap on the lance. They are largely replacing the knapsack sprayers for similar uses, and have a working capacity of 1 to 3 gallons (fig. 265).

[1] Supplied by Messrs Weeks, Maidstone.

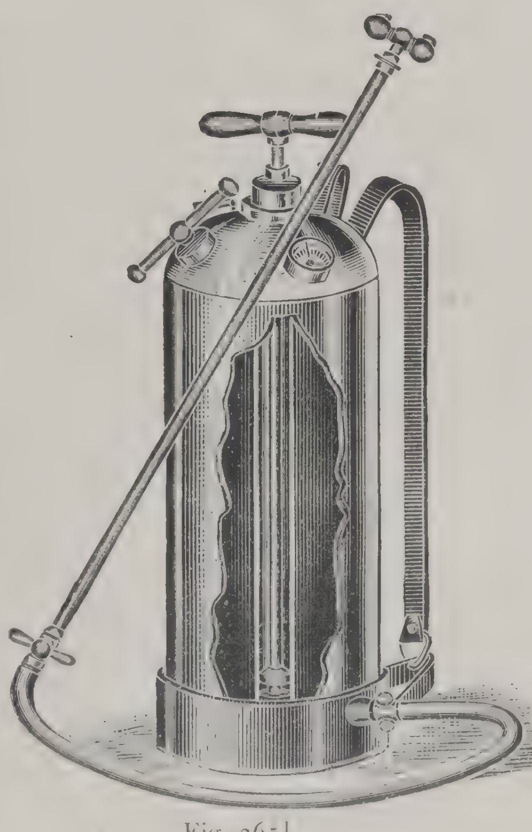


Fig. 265[1].

6. Barrel Sprayer

This is a popular type in America. It is mounted on a timber base and the pump handle has a backwards-and-forwards movement, which uses the back and hip muscles and can be worked for longer without fatigue than the up-and-down type. It is usually operated and carried on a farm cart or wagon. Fig. 266 shows a compact outfit manufactured by the Deming Co., and costing about $72 (at normal rate of exchange=£15).

Fig. 266.

7. Barrow Sprayers (figs. 267, 268)

This is a very popular hand-type of sprayer and is suitable for small plantations. The pump is worked by a vertically operated lever handle, and the tank, which may be of iron or wood, has a capacity of from 12 gallons in the smallest size to 50 gallons in the largest kind made. Tanks may also be had of iron, lead coated, and this is the most suitable material for general purposes. They are supplied with good lengths of hose and long lances, so as to reach high standard trees. The labour required is three men, one to work the pump and two to apply the spray, with two branch hoses and lances. Price about £24.

A similar type of machine is also made to be horse-drawn with a tank capacity of 100—110 gallons.

In America, a very popular form is barrel-shaped and mounted upon wheels.

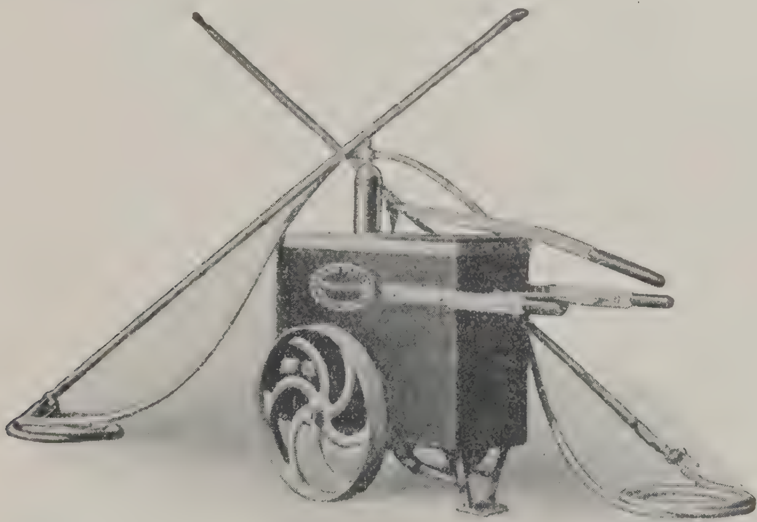


Fig. 267.

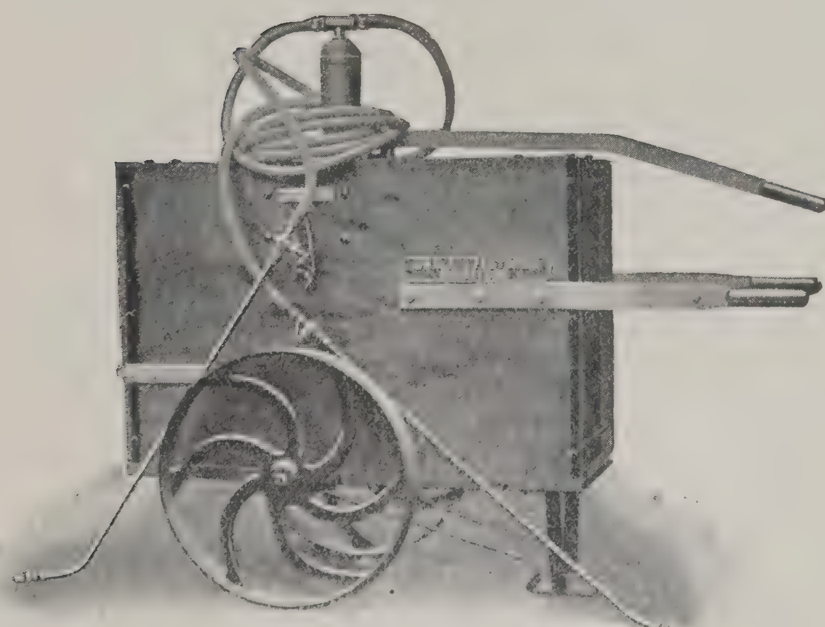


Fig. 268.

8. Two-manual Hand Sprayers

These are usually of the vertically operated type, and have handles on each side of the sprayer for two labourers. They may be obtained with or without tanks. In one popular type[1], the tank is in the form of a 10 gallon barrel, mounted on the carriage, alongside the pump (fig. 269). Price about £33.

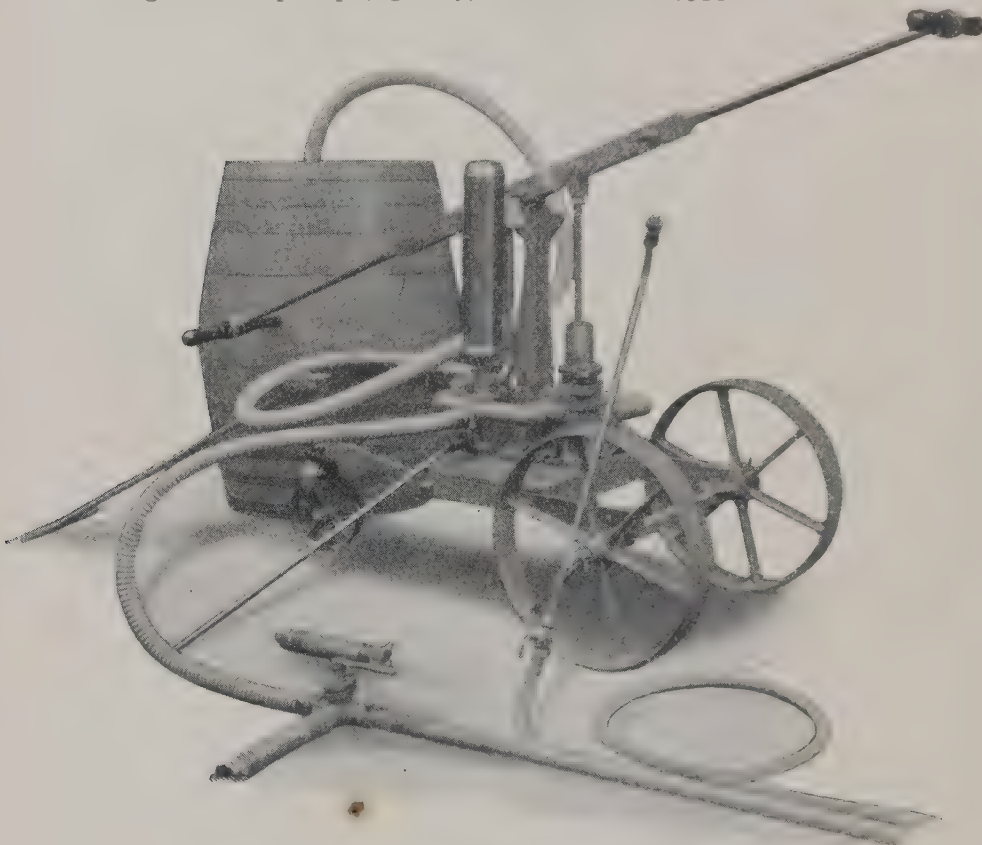


Fig. 269.

9. Horizontally Operated Pump

This is the type shown in the illustration (fig. 270) and may be worked by one or two men. The advantage claimed is—as also in the case of No. 5—that it is much easier to maintain a good pressure, and the muscles used in operating are those which can work longer without fatigue. It must be used with a separate tank, as this is not supplied. Rotary, hand power sprayers are

[1] Manufactured by Messrs Weeks, Maidstone.

also made and the same advantage is claimed from them, viz. a minimum of fatigue.

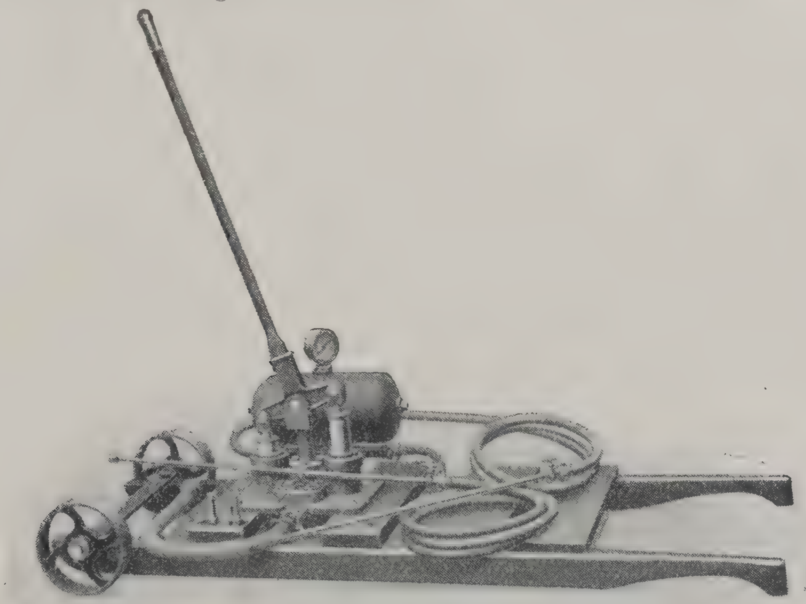


Fig. 270[1].

10. Traction Pumps

These sprayers are operated by chains from the wheels on which the tank and pump are mounted. They are much used for spraying hops, but are generally unsuitable for trees, unless a hand action on the pump is also supplied. They are made for draught with two or three horses, according to the nature of the ground. A large number of nozzles, adjustable to any style, are supplied which project out on each side of the sprayer (see fig. 271)[2]. Price about £110. Similar designs operated by power are now manufactured and are much to be preferred since they are more regular in action (see fig. 272)[3]. Price about £200.

A similar pattern of sprayer is also used for spraying ground crops, such as potatoes, etc. In this case the nozzles are arranged on a large horizontal pipe at the back of the sprayer. For potato spraying, pairs of nozzles are arranged to spray each side of the potato hills; with other crops, the spray points downwards on to the rows. All nozzles are adjustable for different distances of rows (fig. 273)[2]. Price about £51.

[1] Sold by Messrs Craven, Evesham.
[2] Manufactured by Messrs Weeks, Maidstone.
[3] Manufactured by Messrs Drake and Fletcher, Maidstone.

11. Power Sprayers

All growers with plantations exceeding 20 acres will be well advised to invest in a power sprayer for their work. There is

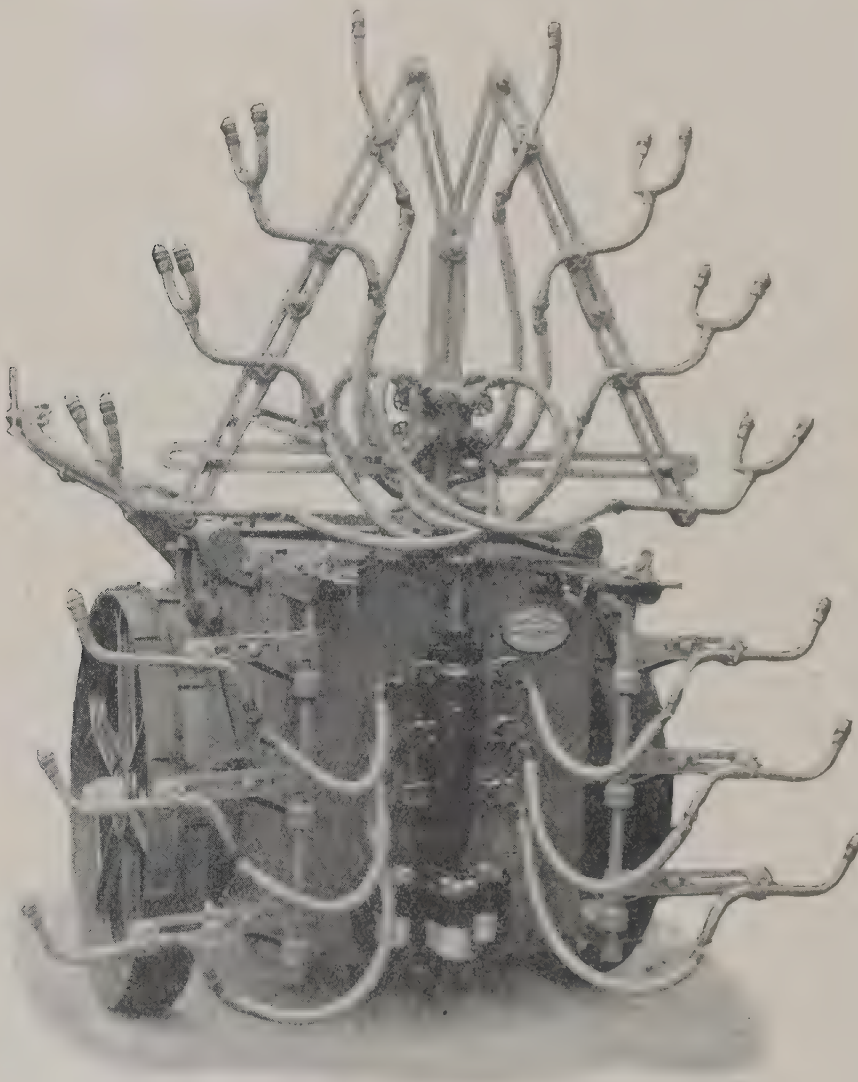


Fig. 271.

a great economy of time and labour and an enormous increase in efficiency – every practical foreman knows how the pressure drops on hand-operated sprayers when his back is turned. The time factor

however is of the *greatest* importance—when bad attacks of pests occur every minute is golden, and this is when the power plant scores. Another great advantage of power plant is the very high pressure that can be maintained—up to 200 lbs. per square inch

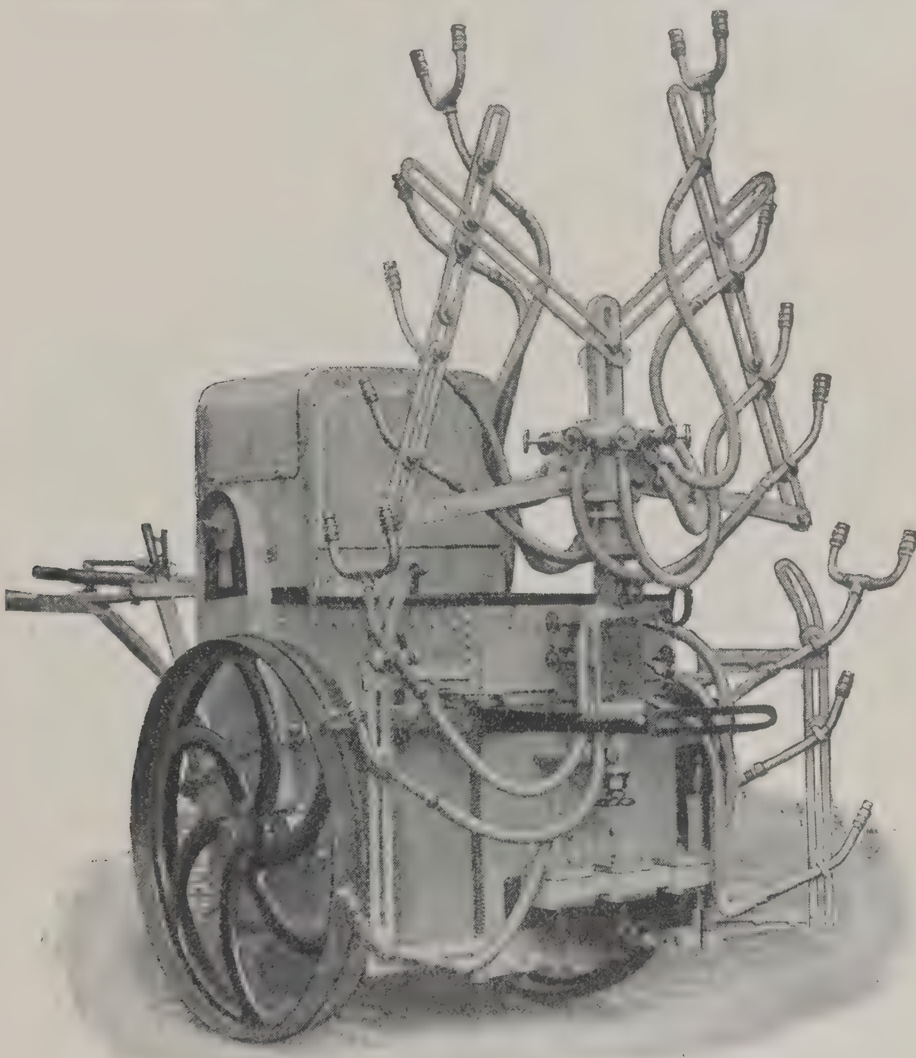


Fig. 272.

and over. This ensures the spray reaching the highest trees and produces, with correct nozzle adjustment, the mistiest of sprays. Excellent power sprayers are procurable in this country, and American machines can also be obtained.

The grower is, however, advised to make quite sure that spare parts can be readily obtained for these latter before purchasing. Nothing is more annoying, and in fact often disastrous, than to find an essential part of the sprayer requires replacement at the last minute, when such parts are not obtainable without considerable delay.

The figures show a few standard types of sprayers suitable for all sizes of plantations. The capacity ranges from 4 to 12 gallons of spray fluid per minute.

Fig. 273[1].

A. Small Power.

These are designed for the small grower who requires an inexpensive type as an alternative to hand labour. In the present high labour costs, they should prove a very attractive alternative to the latter.

[1] Manufactured by Messrs Weeks, Maidstone.

1. Fig. 274 shows a low-priced, but thoroughly efficient, form of this type. It is practically an engine-operated hand sprayer of the barrow type, but the pump is superior to those supplied on such sprayers. The engine is $1\frac{1}{2}$ to 2 horse-power and will easily supply two nozzles. It is very portable, can be moved about by hand, and

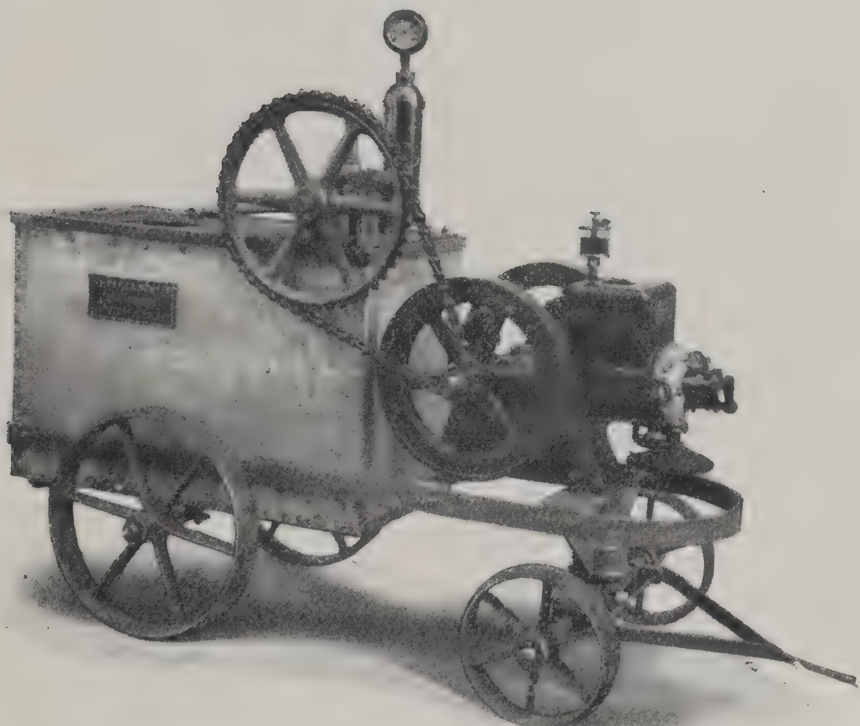


Fig. 274[1].

has all the advantages of the hand type. It would undoubtedly be of great advantage to very many small growers to use a power sprayer of this type. It is also useful for small isolated plantations or orchards.

The present price of the sprayer complete is about £71. 10*s*.

[1] Manufactured by Messrs Weeks, Maidstone.

2. The figure (275) shows a small portable type, supplied by an American firm[1]. It may readily be conveyed through the plantations on a hand-cart. The engine is a first-rate make of $1\frac{1}{2}$ H.P., water cooled. It is coupled to the pump by means of toothed gear wheels, and the pump is of the duplex type operated by a "walking beam" as shown in fig. 262. The tank is a 50 gallon barrel with large filling hopper, and is provided with a mechanical paddle. The frame is of channel steel, and the mechanical parts of first-rate workmanship throughout. Approximate price \$295 (at normal rate of exchange=about £61).

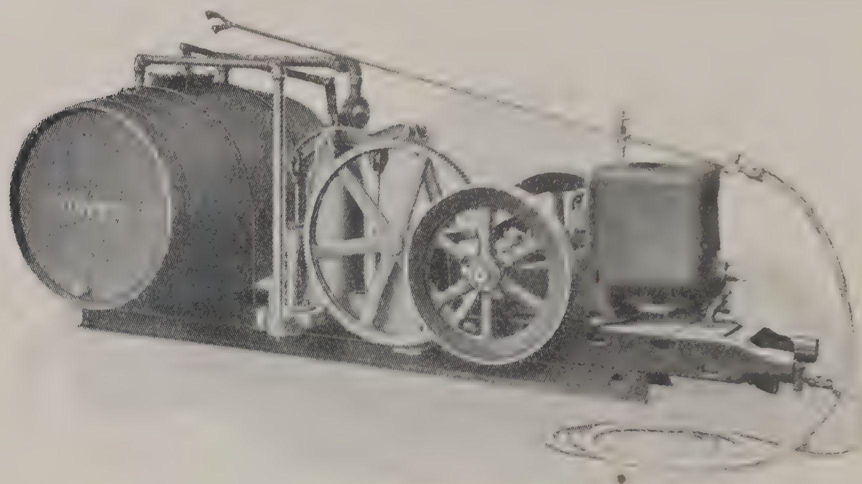


Fig. 275.

B. MEDIUM POWER.

(*a*) The large figure (276[2]) shows a typical medium powered plant, priced complete at about £125. It is of stout build and workmanship, has 2-throw high pressure ram pumps and is mounted on a steel frame with an iron tank. It is capable of supplying 4 to 8 nozzles at high pressure, being supplied with a 3 H.P. (or $1\frac{1}{2}$ H.P.) petrol or oil, water-cooled engine. This is probably the most suitable type for the average grower. It can also be used as a stationary engine to pump the spray fluid through the main pipes and branches.

(*b*) The American type[3] (fig. 277) is also a most satisfactory sprayer

[1] Manufactured by the Hayes Pump and Planter Co., Galva, Illinois, U.S.A.

[2] Manufactured by Messrs Drake and Fletcher, Maidstone.

[3] Manufactured by the Deming Co., Salem, U.S.A.

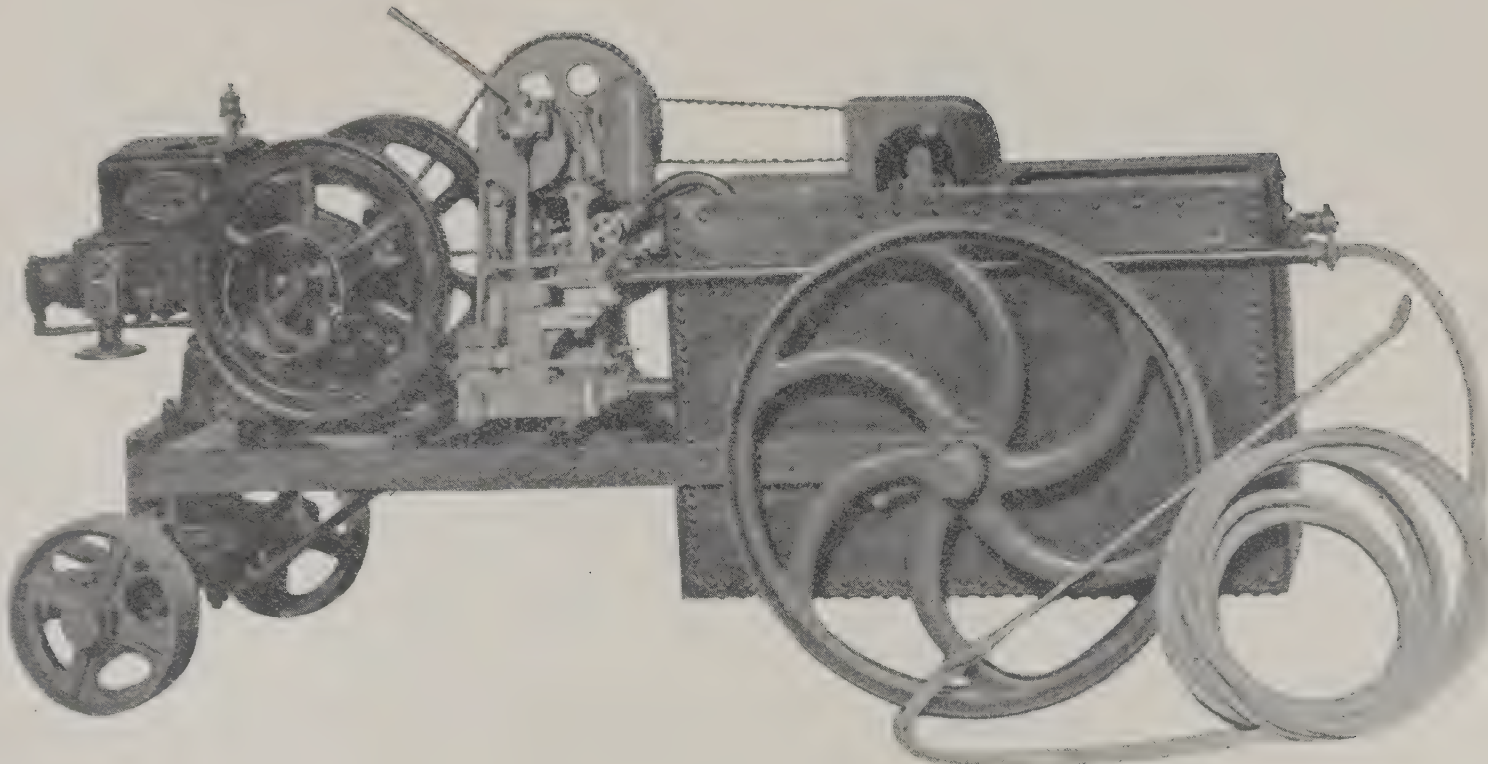


Fig. 276.

for the average sized plantation. A platform for spraying large trees is provided over the tank and engine and a very efficient mechanical agitator is fitted. The pump is a duplex type similar to that shown on fig. 278, and is coupled by belt with the engine (2 horse-power). It will maintain a pressure of 250 lbs. per square

Fig. 277.

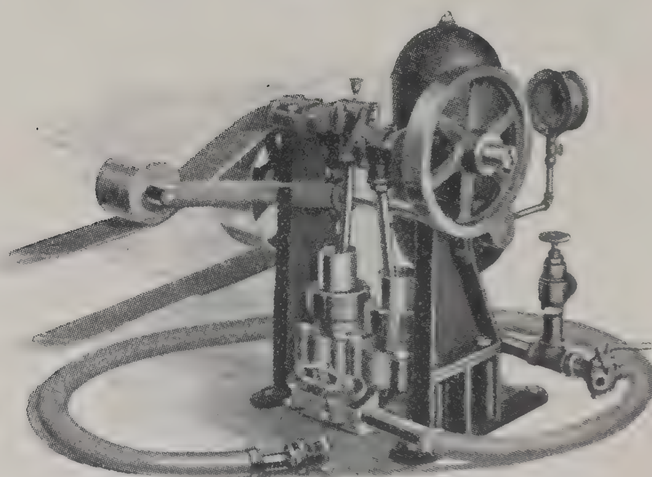


Fig. 278.

inch, and will supply two nozzles with large hole discs and four with small discs. Price approximately \$300 (at normal rate of exchange = about £65).

(*c*) Another American medium powered sprayer is shown in fig. 279[1]. It is fitted with a 2-throw pump and Fairbanks-Morse $1\frac{1}{2}$ H.P. water-cooled kerosene engine.

[1] Manufactured by the Hayes Pump and Planter Co., Galva, Illinois.

This is coupled to the pump by means of toothed gear wheels and the whole forms a very well-designed and compact outfit. The tank is of 100 or 150 gallons capacity, and the top acts as a platform for spraying. It is mechanically agitated and is guaranteed

Fig. 279.

for a pressure of 300 lbs. per square inch. It delivers $3\frac{1}{2}$ gallons per minute. Price approximately \$450 (at normal rate of exchange = about £94).

C. High Power.

The high powered plant, suitable for large acreages of fruit are generally worked in connection with a permanent system of iron

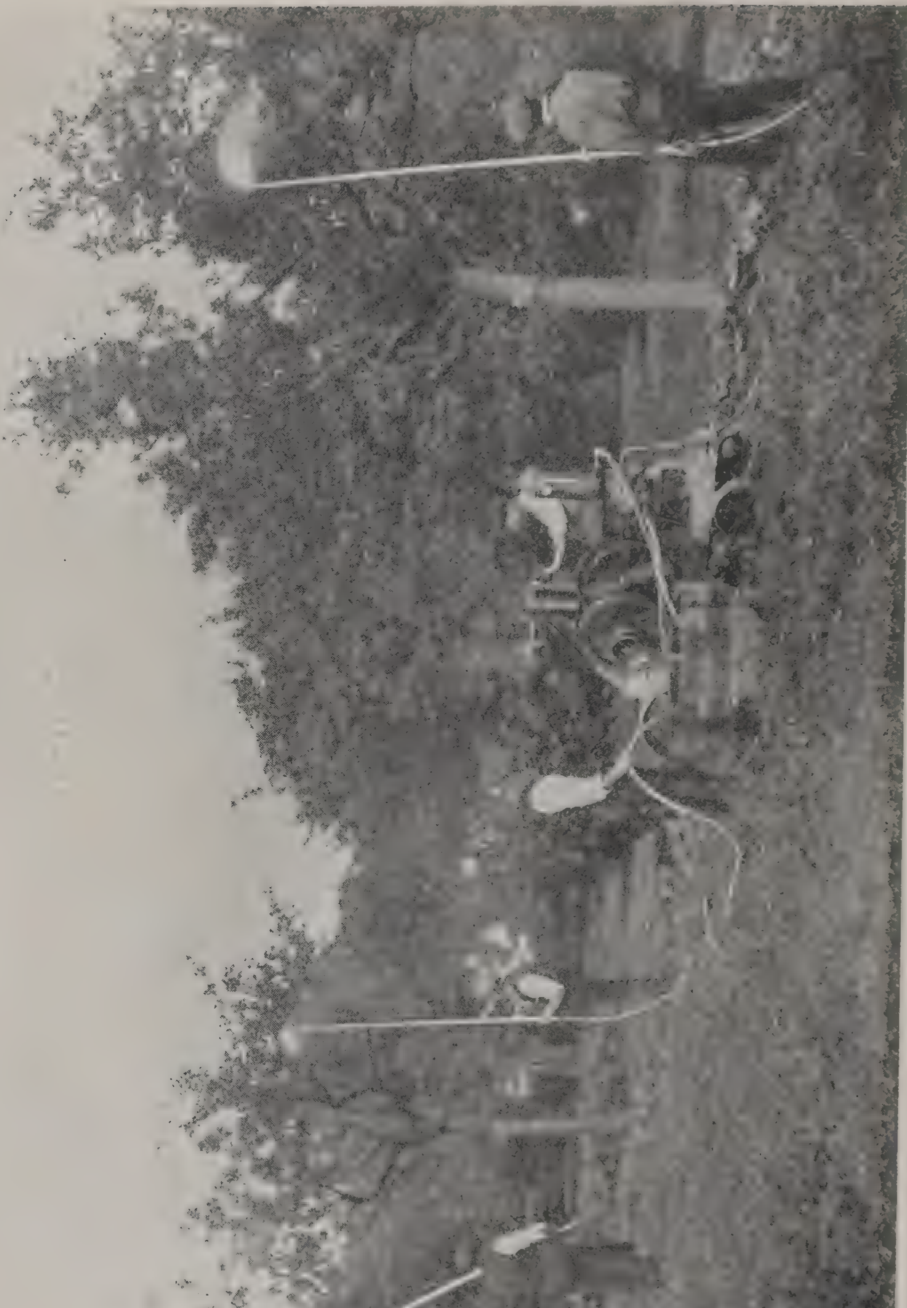


Fig. 280. Spraying standard trees with a medium power petrol-driven outfit.

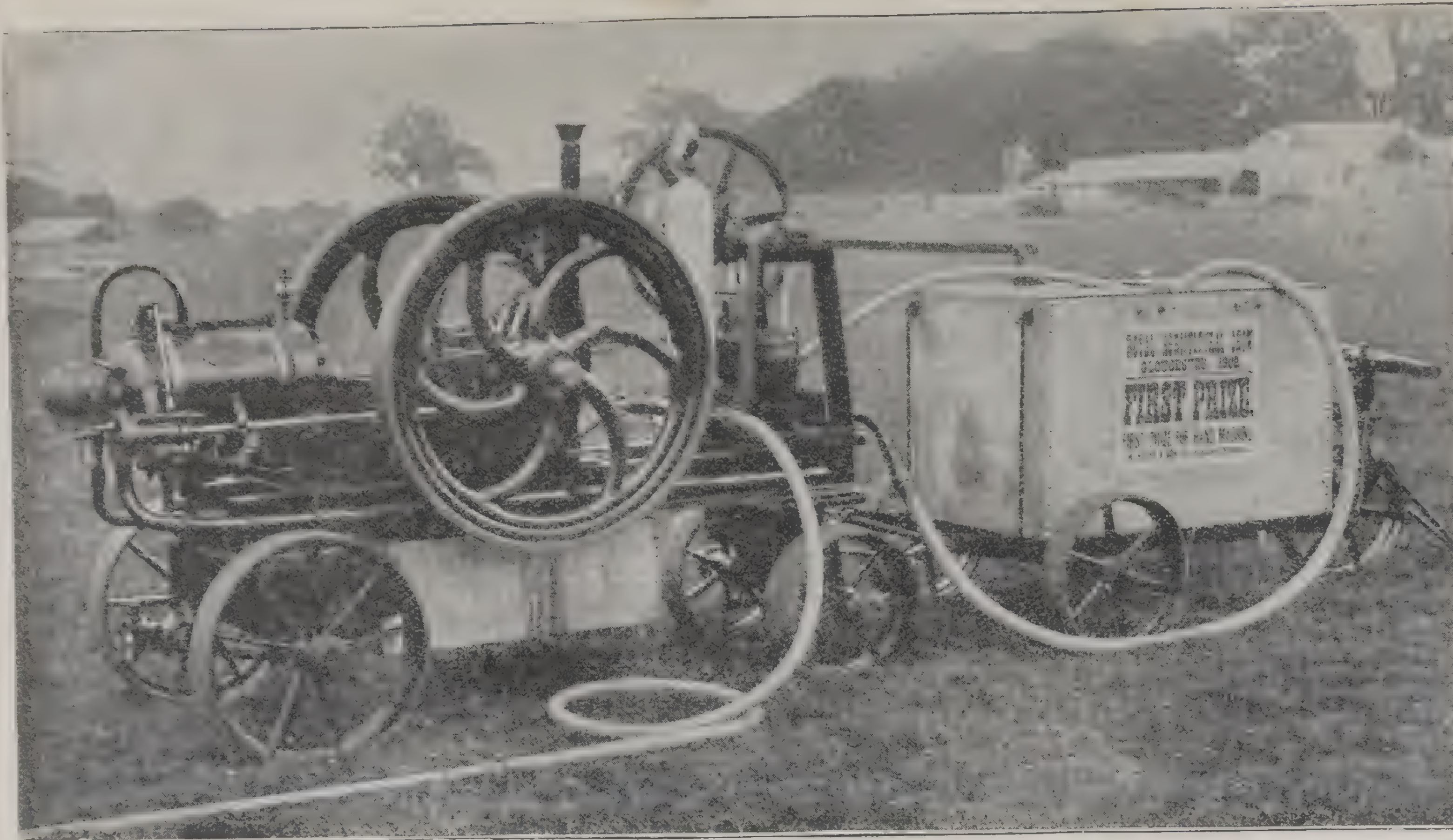


Fig. 281.

piping, laid so as to supply large areas of orchards from a common centre. This is undoubtedly the most efficient and economical method. The engine and pump is then placed in the most convenient situation for the water supply and for mixing the wash, and this is pumped through the permanent mains to wherever it is required to be sprayed. The alternative method is to move the machine along the main roads of the estate and employ a system of portable iron and indiarubber piping to reach down the rows of fruit. This is certainly a less efficient method, and has the great drawback that the plant has to be kept fed with water, but it has

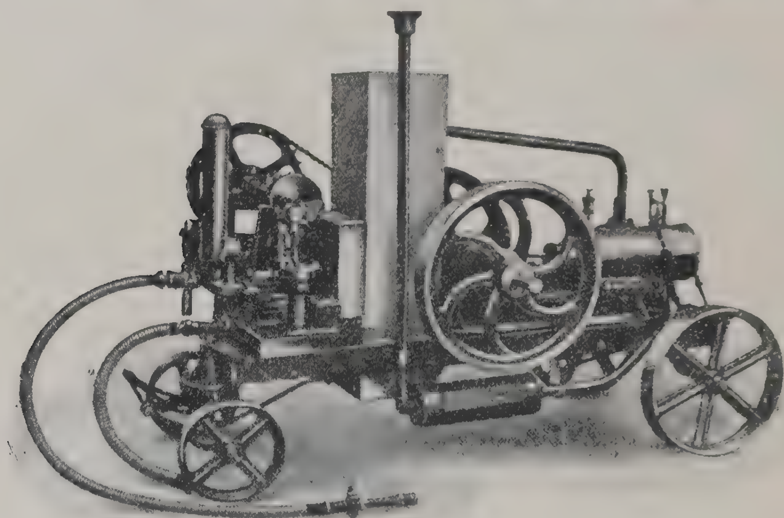


Fig. 282[1].

to be adopted where a permanent pipe system is not installed. The following are three types of high power plant:

1. This plant (fig. 281[1]) has a maximum capacity of 1200—1900 gallons of liquid per hour. It is fitted with 5 H.P. or larger engine, and a set of 3-throw plunger pumps of gun metal, with a separate tank mounted on a carriage for the spraying mixture (if desired). It is capable of supplying 12 to 16 spraying nozzles at one time. The engine in this case is a Blackstone. Price of the 5 H.P. is approximately £308, and of the 3 H.P. £239.
2. The figure (282[2]) shows a similar type of plant of which the entire

[1] Messrs Weeks, Maidstone.
[2] Messrs Drake and Fletcher, Maidstone.

machine is manufactured by the same firm. Any other make of oil engine may be supplied if desired. The power ranges from 3—12 H.P. and the pumps are of the 3-throw plunger type[1], working at high pressure. The plant is adequate for the largest fruit acreages. The price of the 5 H.P. is approximately £275.

3. The figure (283) shows a powerful American type[2]. It is mounted on a carriage with a 200 gallon tank, and is specially suitable when very tall trees have to be dealt with. The pumps are capable of delivering at a pressure of 300 lbs. per square inch. The engine

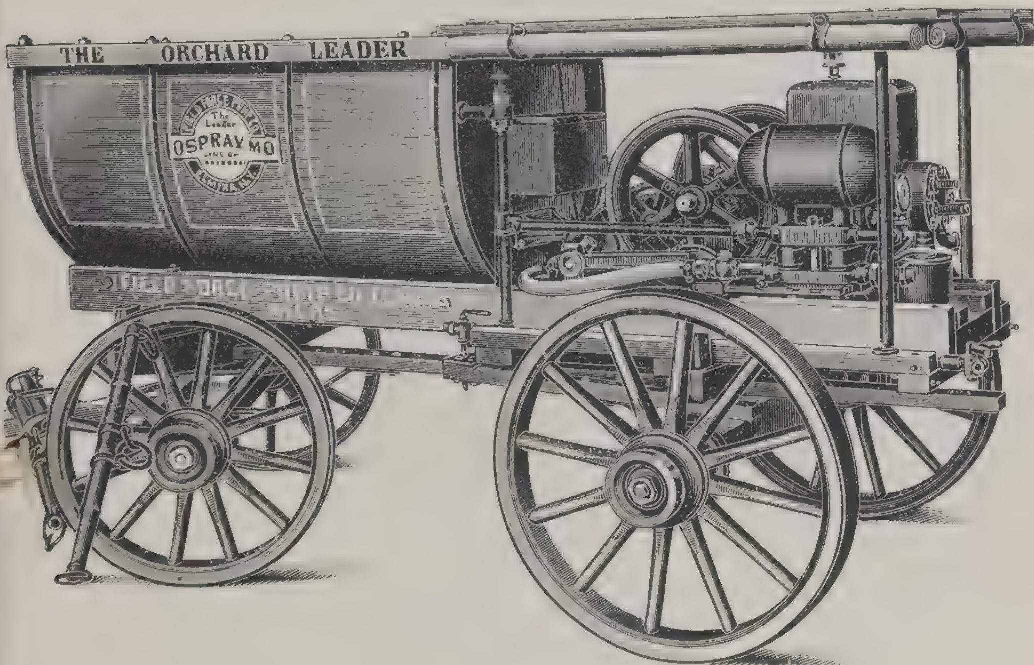


Fig. 283.

uses gasoline as fuel, and is of $4\frac{1}{2}$ H.P. (a larger type has a 10 H.P. engine). The cover over the engine acts as a platform for spraying, and the working parts can be protected by waterproof blinds. The approximate price of the outfit is (without carriage) $516 and $725 (at normal rate of exchange about £108 and £151).

12. Dusting or blowing appliances

Like the liquid sprayers, these vary in size from the hand-operated type to the large capacity traction machines. For nurseries and

[1] See illustration of this pump, Appendix XI, p. 709.
[2] Supplied by the Field Force Pump Co., Elmira, N.Y.

small growers the hand type or, better, the drum or knapsack type are suitable (fig. 284).

For sulphuring hops, more complicated sulphurating machines are necessary. These are horse drawn, and the sulphur is mechanically distributed by means of machinery worked by gear from the wheels. (See fig. 285. Price about £32[1].)

Fig. 284.

Another type of powder distributor[2] adapted for standard fruit when dry sprays are used is that shown in fig. 286. (See also Appendix VIII, page 706.)

[1] Messrs Weeks, Maidstone.

[2] Supplied by Messrs Craven, Evesham.

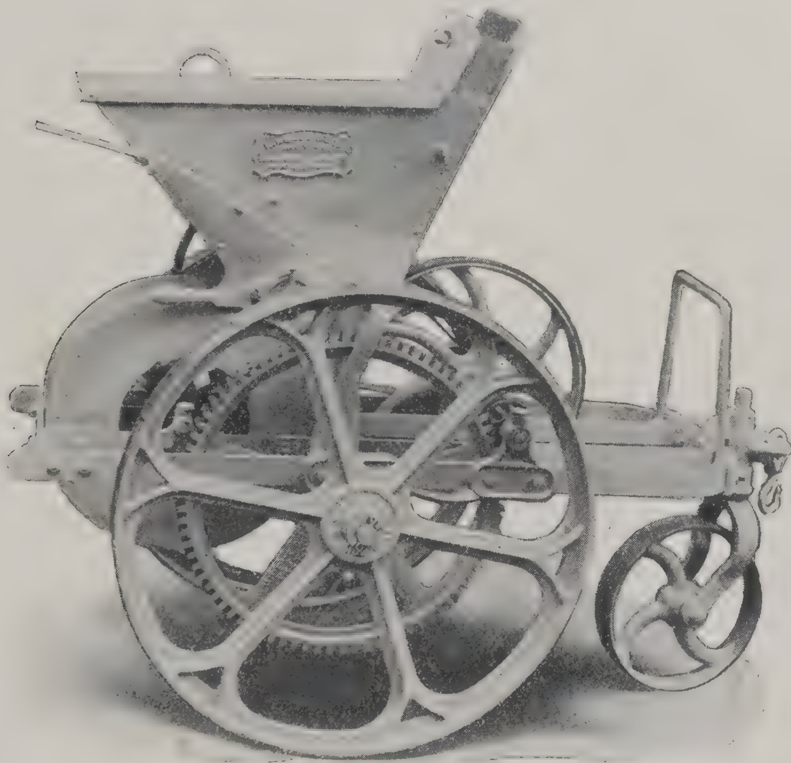


Fig. 285.

Fig. 286.

CHAPTER 45

Spraying Methods

For small plantations, the portable hand sprayers are provided with a suitable length of delivery hose and are then pushed along the rows, so as to serve the trees on each side corresponding to the length of hose.

Although most of the power sprayers are mounted on a carriage of some sort, and therefore portable, it is, as previously mentioned (page 656), of great advantage to have steel mains running along each orchard from end to end.

At suitable points cocks (taps) are placed to which the lengths of hose may be attached for spraying trees in that section. A safety valve must be provided so that no damage occurs if all the cocks happen to be shut off.

When this system is used, the engine stands on the main cart track, and can be served with material very conveniently. It is usual to arrange so that the machine pumps its own water from a ditch or river if possible.

Lances

These are rigid lengths of pipe made in bamboo or thin brass tube, and may be any length (or screwed in sections) so as to reach the highest trees.

Hose

This should be only the *best 4-ply* so that no risk of bursts at inconvenient times may be incurred.

Connections

A variety of connections made of brass are available, which may be employed to suit various purposes.

Strainers

Fine brass wire strainers should always be employed on the tanks. There is nothing so annoying as stopped-up nozzles and this is bound to happen with many materials, especially those containing lime, if not carefully strained.

Applying the Spray

A good deal of experience is necessary to apply the spray in an efficient and yet economical manner. Plenty of spray may be given with CONTACT WASHES and it is not of great importance, except from an economical point of view, if the spray is in excess and drips off the leaf. When spraying with Bordeaux, arsenate of lead and lime-sulphur, in summer, however, it is essential that no excess is sprayed and that the trees receive an even coat of the material, but no dripping off the leaves occurs. A very fine adjustment of the nozzle must be obtained and an actual *fog* produced as near as is possible. Also the operator must not stand too near the tree. It is well to thoroughly educate a few men on the right manner of spraying, and form a standing gang of these, so that they grow in experience each year. A strict check on the amount of material used should be kept and orchards inspected thoroughly after each spraying.

Points to Remember

That in the case of a soap spray, the *soap must be in excess* (seen by the "head of lather" produced) otherwise the liquid will be sticky and will cause trouble with the valves.

That arsenates, Bordeaux and lime sprays must be kept constantly stirred.

That it pays to use only thoroughly efficient materials for spraying, even if the cost is considerable.

That delays are dangerous.

That the sooner treatment is applied, the less damage is done by the pest.

That the annual overhaul of the spraying plant previous to spraying in the spring should not be left till the last minute, so that, if spare parts are required, there is a margin of time for delivery before spraying becomes urgent.

That plant should be thoroughly cleansed and oiled before being put under cover for the slack periods.

The too much force in spraying hops, especially during the last period when the "pin" is forming, will result in damage. Powerful insecticides should also be reduced in percentage in the wash, and too large an excess of soap should also be avoided during this period.

CHAPTER 46

Combined Sprays

In cases where there is a great shortage of labour it is often preferable to use a **combined wash** for two or three kinds of pests rather than to only wash once for one of them. This is, however, with a few exceptions by no means an advisable practice for the following reasons:

(*a*) Each type of remedy generally requires application to the plant in a *special manner* and in particular with a varying adjustment of the spraying nozzle.

(*b*) Each pest has its own *particular period* when it is most open to treatment.

(*c*) Many of the substances used for spraying *react with one another chemically*, whereby the efficiency of one or both may be reduced, or risk of injury to the leaves may be incurred.

(*a*) Thus, arsenate of lead, and other caterpillar sprays, require a VERY FINE MISTY SPRAY. Nicotine, on the contrary, requires, especially for caterpillar, a *relatively coarse*, penetrating spray, provided by a coarse adjustment of the nozzle. Further, it is nothing like so efficient in its action when used apart from soap, while the latter should not be used with arsenate of lead, as, not only is there danger of scorching[1], but it will be found that the arsenate will tend to run off the leaves instead of adhering to them. The same remarks apply to Bordeaux used with nicotine.
In the case of the use of Bordeaux with arsenate of lead, this objection does not apply.

(*b*) An instance of this is in the case of apple aphis, and psylla (sucker). These should be sprayed before they enter the buds, while they are still exposed and just after hatching (see fig. 193). This is, of course, *much too early* to spray for caterpillar, so that a combined arsenate-nicotine wash will waste either the nicotine or the arsenate if applied for both caterpillar and aphis.

[1] See remarks on page 665.

In the case of nicotine used with lime-sulphur, the wash is usually applied too early for the nicotine to have any effect (winter strength) or too late to be of any use (summer strength).

The use of a combined wash of arsenate of lead and lime-sulphur is also inadvisable, as besides any chemical action which may be set up, the lime-sulphur is much less efficient at the weak strength

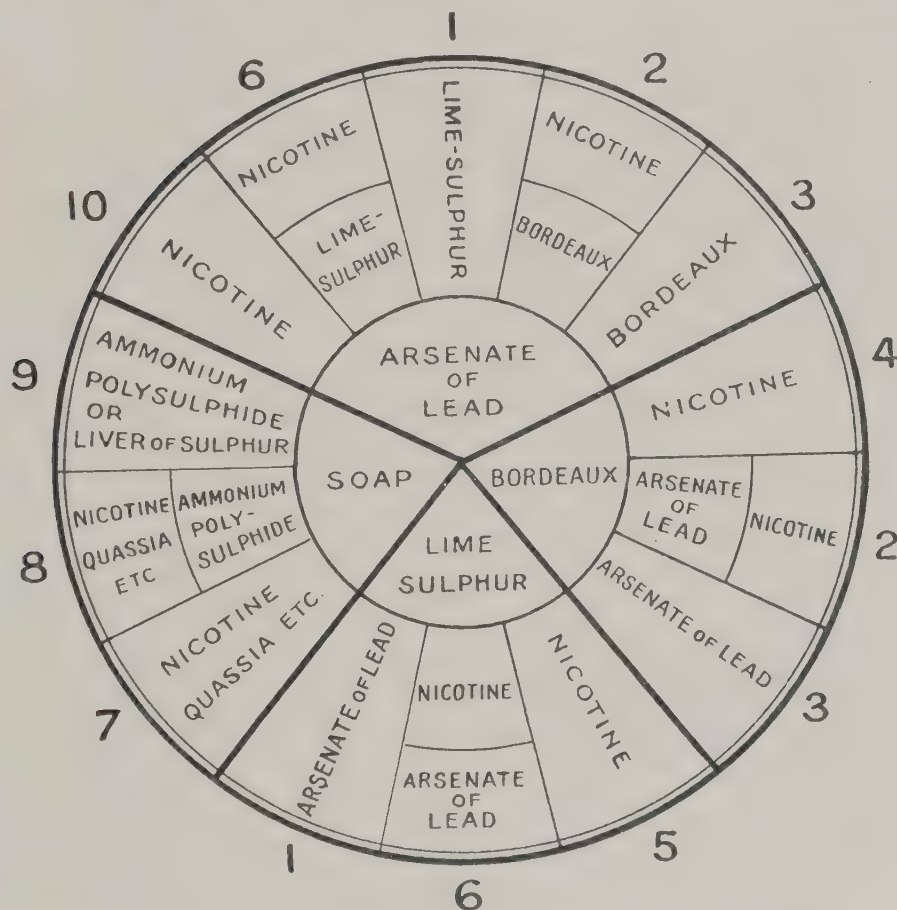


Fig. 287. Diagram showing materials which can be used together as a combined spray without undergoing chemical change.

at which it must be used when the trees are best open to deal with a caterpillar attack.

(c) Many growers have tried using soap with various other sprays, but in most cases the soap is either curded out altogether or *chemical action is set up* which results in severe leaf scorching. Thus lime-sulphur and Bordeaux destroy the soap, the former

completely, the latter partially, while, although some samples of arsenate of lead do not curd out the soap—these are free from excess of lead—the soluble alkali salt of the arsenate is liable to be formed which is certain to cause injury to the plants. (See below.) The attached diagram (fig. 287) shows the combined sprays that it is possible to use without one or other of the constituents being altered or destroyed. The following brief comments may be useful:

1. **Arsenate of lead—lime-sulphur**

   See remarks in § *b* above. In America better results have been obtained by using calcium arsenate in place of the lead salt in this mixture.

2. **Arsenate of lead—Bordeaux—nicotine**

   The nicotine is much less powerful when used apart from soap (see § *a* above). This should, nevertheless, be a good combination to spray if used at exactly the right time.

3. **Arsenate of lead—Bordeaux**

   As far as is known this is an entirely unobjectionable combination and may be very successfully employed when apple scab is present as well as caterpillar.

4. **Bordeaux—nicotine**

   The same remarks apply as in the case of 2 above.

5. **Lime-sulphur—nicotine**

   Remarks as for 2 and 4 above.

6. **Lime-sulphur—nicotine—arsenate of lead**

   Remarks as for 1 and 2 above.

7. **Soap—nicotine; soap—quassia, etc.**

   These are normal mixtures and not really "combined" sprays.

8. **Soap—ammonium polysulphide—nicotine, quassia, etc.**

   This should form a very excellent combination for fungus (especially mildew) spraying and sucking insects. It must be remembered, however, that "A.P.S." is still in its experimental stages, and should be used cautiously as it has marked scorching tendencies on young foliage.

9. **Soap—"A.P.S."; soap—liver of sulphur**

   Normal mixtures.

10. Arsenate of lead—nicotine

Much employed by growers as an early spring wash. Has a good deal to be said for it as a labour-saving combination, but, as before stated, the nicotine is much less powerful than if used by itself with soft soap. Further, the nicotine should be applied earlier in the season in the case of attack by psylla (apple sucker), see § *b* above.

As regards the advisability of using arsenate of lead with soft soap, from the standpoint of possible damage to the leaves of the tree, this is a chemical question. Statements which are apparently very conflicting have been made by various authorities from time to time. Some have advised its use and found no scorching while others have strongly condemned the combination both on the grounds stated above and on account of the resulting damage.

The author has made careful investigations on the subject and the following is a summary of the results obtained:

1. The scorching action is largely dependent on the chemical composition of the soap used. If this is free from any trace of *caustic alkali* there is little or no chemical action on the arsenate of lead and thus no scorching results. If, on the other hand, there is free caustic alkali present—which often happens in commercial soaps—there is soluble arsenic formed which produces severe leaf-damage.
2. All makes of arsenate of lead are not the same chemically. Those which contain most of the *basic* arsenate are least likely to cause scorching even with soaps which contain some free alkali.
3. The degree of chemical action depends upon the *length of time* during which the soap is allowed to act upon the arsenate of lead before the mixture is sprayed. A greater degree of damage therefore occurs the larger the spray mixture is kept before using.
4. In the case of some brands of arsenate of lead which contained soluble lead acetate, the soap was curdled and rendered useless for spraying. Such varieties of arsenate are unsuitable for the purpose.

Summarising these results, if a grower decides to use soap with his arsenate, it is necessary in order to avoid less damage to obtain a *neutral* soap (guaranteed to contain no free alkali) and to use this with arsenate of lead which the manufacturers will guarantee is suitable for the purpose. Further, it is advisable to spray the mixed wash into the trees as quickly as possible.

SECTION X

SPRAYING CALENDAR

SECTION X

SPRAYING CALENDAR

The following calendar has been carefully compiled to serve as an index to the rest of the book, and it gives the approximate spraying operations for each month of the year. Practically all the pests are dealt with, and short directions are given, *but reference in all cases should be made to the pages indicated.*

This is absolutely necessary because it is not possible to give details with the limits fixed by a table, and further, there are often special precautions to be observed—e.g. not to spray with arsenical poisons when the fruit is ripening, etc.

As the seasons are liable to considerable variation from year to year, only a general indication can be given, and a good look-out should be kept for the **first appearance of the pest.**

It cannot be too strongly emphasised, as frequently stated in other parts of the book, that it is of the utmost importance to avoid delay, and to deal with each pest before it either has time to find shelter inside the buds, or to do permanent and irreparable damage to the tree.

JANUARY

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Bud Moth ...	Caterpillar ...	... ...	Lime-sulphur ...	Any time during month	65	430
Buff-Tip Moth ...	Pupa ...	Poultry in orchards ...	... ...	All month	69	
Clouded Drab Moth	,, ...	,, ,, ...	... ...	,, ,, ...	84	
Codling Moth ...	Caterpillar ...	... ...	Caustic Emulsion ...	End of month	88	413
,, ,, ...	,, ...	... ...	*or* Lime-sulphur ...	,, ,, ...	88	430
Currant Clearwing Moth	,, ...	Prune off attacked shoots	... ...	Any time during month	81	
Dot Moth ...	Pupa ...	Poultry in orchards ...	... ...	All month	96	
Ermine (small) Moth	Caterpillar ...	... ...	Caustic Soda ...	End of month	100	413
,, ,, ,,	,, ...	... ...	*or* Lime-sulphur ...	,, ,, ...	100	430
Magpie Moth ...	,, ...	... ...	Sticky bands ...	Middle to end of month	134	404
,, ,, ...	,, ...	... ...	Lime	,, ,, ,,	134	420
,, ,, ...	,, ...	... ...	*or* Soot	,, ,, ,,	134	457
Peppered Moth ...	Pupa ...	Turn over ground ...	... ...	End of month	147	
Nut Weevil ...	Grub ...	Cultivate soil ...	... ...	Any time during month	198	
Raspberry Weevil	,, ...	Remove rubbish ...	... ...	,, ,, ,,	202	
Red-Legged Weevil	,, ...	,, ,, ...	... ...	,, ,, ,,	206	
Apple Sawfly ...	Maggot ...	Remove surface soil ...	Dig in soil insecticides	Middle to end of month	237	432
Apple-Oat Aphis...	Egg	Destroy prunings ...	... ...	Any time during month	281	
Green Apple Aphis	,, ...	,, ,, ...	... ...	,, ,, ,,	283	
Strawberry Aphis	,, ...	Cut off old leaves and burn	... ...	,, ,, ,,	325	
Woolly Aphis ...	All	... ...	Caustic Emulsion ...	,, ,, ,,	327	413
,, ,, ...	,, ...	... ...	Inject Carbon Bisulphide	,, ,, ,,	327	410

JANUARY (*continued*)

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Brown Scale ...	Louse ...	... ...	Lime-sulphur ...	Any time during month	361	430
Mussel Scale ...	Egg	... ...	Caustic Soda ...	,, ,, ,,	355	413
,, ,, ...	,, ...	... ...	*or* Lime-sulphur ...	,, ,, ,,	355	430
,, ,, ...	,, ...	... ...	*or* Paraffin ...	,, ,, ,,	355	441
Apple Blossom Wilt	Pustules ...	Cut off cankered spurs	... ...	,, ,, ,,	494	
,, Scab ...	Winter (ascigerous)	Cut off diseased shoots	... ...	Toward end of month	510	
Brown Rot ...	On fruit ...	Remove mummified fruit	... ...	First two weeks ...	496	
Cherry Leaf Curl	Mycelium ...	Prune off affected branches	... ...	Before last week ...	521	
,, ,, Scorch	Winter (ascigerous)	Remove dead leaves ...	... ...	Any time during month	523	
Cherry Witches'-Brooms	Mycelium ...	Cut out brooms ...	... ...	,, ,, ,,	528	

FEBRUARY

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Bud Moth	Caterpillar	... ...	Lime-sulphur ...	Any time during month	65	430
Buff-Tip Moth ...	Pupa ...	Poultry in orchards ...	... ...	All month	69	
Case Bearer Moth ...	Caterpillar	... ...	Lime-sulphur ...	Any part of month ...	74	430
Clearwing (currant) Moth	,,	Prune off affected shoots	... ...	,, ,, ...	81	
Codling Moth	,,	... ...	Lime-sulphur ...	,, ,, ...	88	430
Ermine (small) Moth ...	,,	... ...	Caustic Soda ...	,, ,, ...	100	413
,, ,, ,, ...	,,	... ...	*or* Lime-sulphur ...	,, ,, ...	100	430
Figure of Eight Moth	Eggs ...	Remove shoots with eggs	... ...	,, ,, ...	105	
Magpie Moth	Caterpillar	... ...	Sticky bands ...	,, ,, ...	134	404
,, ,, ...	,,	... ...	Lime	,, ,, ...	134	420
,, ,, ...	,,	... ...	*or* Soot	,, ,, ...	134	457
Peppered Moth ...	Pupa ...	Turn over ground ...	... ...	,, ,, ...	147	
Apple Sawfly	Maggot	... ...	Dig in soil insecticides	Up to middle of month	237	432
Pear Midge	Pupa ...	Poultry in orchards ...	... ...	Any time during month	263	
Currant-Lettuce Aphis	Eggs ...	Prune and destroy prunings	... ...	,, ,, ,,	302	
Raspberry Aphis ...	,,	Destroy winter prunings	... ...	,, ,, ,,	321	
Strawberry Aphis ...	,,	Cut off old leaves and burn	... ...	,, ,, ,,	325	
Brown Scale	Louse ...	... ...	Lime-sulphur ...	,, ,, ,,	361	430
Mussel Scale	,,	... ...	Caustic Soda ...	,, ,, ,,	355	413
,, ,, ...	,,	... ...	*or* Lime sulphur ...	,, ,, ,,	355	430
,, ,, ...	,,	... ...	*or* Paraffin ...	,, ,, ,,	355	441
Gooseberry Red Spider	Various ...	... ...	Paraffin	,, ,, ,,	377	441
,, ,, ,,	,,	... ...	and Soft Soap ...	,, ,, ,,	377	452
,, ,, ,,	,,	... ...	*or* Liver of Sulphur ...	,, ,, ,,	377	431
,, ,, ,,	,,	... ...	*or* Nicotine ...	,, ,, ,,	377	436
Apple Canker	Mycelium	... ...	Lime-sulphur ...	,, ,, ,,	501	430
Peach Leaf Curl ...	... ...	... ...	Burgundy Spray ...	Between middle and end of month	556	610
,, ,, ...	... ...	... ...	*or* Bordeaux Spray ...	Between middle and end of month	556	605

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Bud Moth	Caterpillar	...	Arsenate of Lead	End of month	65	397
Buff-Tip Moth	Pupa	Poultry in orchards	...	All month	69	
Gold-Tail Moth	Caterpillar	...	Lime-sulphur	2nd or 3rd week	112	430
Lappet Moth	,,	Hand pick caterpillars	Arsenate of Lead	Any time during month	127	397
March Moth	Egg	Destroy egg bands	...	,, ,, ,,	139	
Raspberry Moth	Caterpillar	...	Arsenate of Lead	Twice during month	157	397
Winter Moth	Egg	...	Lime salt wash	Middle of month	176	430
Apple-Blossom Weevil	Beetle	...	Lime-sulphur	End of month	190	430
,, ,, ,,	,,	...	*or* Lime	,, ,,	190	428
,, ,, ,,	,,	...	*or* Nicotine Soap	,, ,,	190	436
Pear Midge	Fly	...	Nicotine Soap	,, ,,	263	436
Blue Apple Aphis	Egg	...	Lime on shoots	Beginning of month	276	428
,, ,,	Lice	...	*or* Nicotine Soap	End of month	276	436
Plum Leaf-Curling Aphis	Stem-Mother	...	Nicotine Soap	Middle of month	313	436
,, ,, ,,	,, ,,	...	*or* Lime	,, ,,	313	428
Big Bud Mite	Mites	...	Carbolic and Soap	Beginning of month	367	410
Leaf Blister Mite	,,	...	Lime-sulphur	End of month	372	430
Gooseberry Red Spider	Spider	...	Nicotine	Beginning of month	377	436
,, ,, ,,	,,	...	and Liver of Sulphur	,, ,,	377	431
,, ,, ,,	,,	...	and Paraffin	,, ,,	377	441
Apple Blossom Wilt	Pustules	...	Ammonium Polysulphide	Middle of month	494	601
,, Brown Rot	On fruit	...	Lime-sulphur	Beginning of month	497	612
,, Mildew	Mycelium	...	,, ,,	Middle of month	507	612
,, ,,	,,	...	*or* Bordeaux	,, ,,	507	605
,, Scab	Various	...	Full strength Lime-sulphur	Early in month	510	612
,, ,,	,,	...	*or* Bordeaux	,, ,,	510	605
Cherry Witches'-Broom	Spores	...	Bordeaux	,, ,,	528	605
Pear Leaf Spot	Conidial	...	Lime-sulphur	End of month	561	612
,, ,,	,,	...	*or* Bordeaux	,, ,,	561	605
Pear Scab	Various	...	Full strength Lime-sulphur	Early in month	564	612
Plum Scab	,,	...	,, ,, ,,	,, ,,	569	612

APRIL

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Blister Moth ...	Egg	... ...	Arsenate of Lead ...	Middle to end of month	58	397
Brown-Tail Moth	Caterpillar	Destroy tents	... ...	Any time during month	61	
Clouded Drab Moth	,, ...	... ...	Arsenate of Lead ...	,, ,, ,,	84	397
Codling Moth ...	,, ..	... ...	,, ,, ,, ...	Directly blossoms fall	88	397
Figure of Eight Moth	,, ...	... ...	,, ,, ,, ...	Any time during month	105	397
Lackey Moth ...	,, ...	Destroy tents	... ...	,, ,, ,,	121	
Lappet Moth ...	,, ...	Hand pick larvæ ...	Arsenate of Lead ...	Till middle of month ...	127	397
Leaf Miner Moth ...	,, ...	Hand pick infested leaves	... ...	Any time during month	132	
March Moth ...	,, ...	... ...	Arsenate of Lead ...	End of month ...	139	397
Mottled Umber Moth	,, ...	... ...	,, ,, ,, ...	Any time during month	143	397
Tortrix Moth ...	,, ...	... ...	,, ,, ,, ...	Early in month ...	166	397
Vapourer Moth ...	,, ...	... ...	,, ,, ,, ...	Any time during month	172	397
Winter Moth ...	,, ...	... ...	,, ,, ,, ...	Early in month ...	176	397
Twig Cutting Weevil	Beetle ...	Jarring on to tarred boards	,, ,, ,, ...	Middle of month ...	207	397
Raspberry Beetle ...	,, ...	... ...	,, ,, ,, ...	End of month	214	397
Gooseberry Sawfly ...	Grub ...	... ...	,, ,, ,, ...	,, ,, ...	242	397
,, ,, ,, ...	,, ...	... ...	*or* Pyrethrum ...	,, ,, ...	242	444
,, ,, ,, ...	,, ...	... ...	*or* Hellebore ...	,, ,, ...	242	421
Plum Fruit Sawfly ...	Fly	... ...	Arsenate of Lead ...	,, ,, ...	253	397
Pear Midge	Maggot ...	... ...	If bad destroy blossoms with Paris Green	Beginning of month ...	263	442
Blue Apple Aphis ...	Lice	... ...	Nicotine and Soap	,, ,, ...	276	436
Green Apple Aphis	,, ...	... ...	,, ,, ,, ...	Regularly during month	283	436
Currant-Lettuce Aphis	Stem-Mother and Lice	... ...	Soft Soap ...	End of month	302	452
,, ,, ,,	,, ,, ...	... ...	and Nicotine ...	,, ,, ...	302	436
,, ,, ,,	,, ,, ...	... ...	and Paraffin ...	,, ,, ...	302	441

APRIL (continued)

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Strawberry Aphis ...	Lice ...	... ...	Soap and Nicotine	Beginning of month ...	325	436
Apple Sucker ...	Nits ...	... ...	Lime coat buds ...	Middle of month ...	337	428
Capsid Bug	Louse ...	... ...	Thick Lime wash ...	End of month	342	428
Leaf Hoppers ...	Adults ...	Knocking off on to tarred boards	Soft Soap and Nicotine	Middle to end of month	350	436
,, ,, ...	,, ...	... ...	and Paraffin Emulsion	,, ,, ,,	350	441
Big Bud Mite ...	Mite ...	Pick off swollen buds	... ...	End of month	367	
Leaf Blister Mite ...	,, ...	Destroy affected leaves	... ...	Early in month ...	372	
Apple Bitter Rot ...	Conidial	... ...	Bordeaux spray	Every two weeks from middle to end of month	491	605
Apple Blossom Wilt	On flowers ...	Remove wilting trusses	... ...	End of month	494	
Apple Mildew ...	Conidial ...	Cut away diseased tips	... ...	Middle of month ...	507	
Cherry Leaf Scorch	,, ...	... ...	Bordeaux spray ...	Early in month ...	523	605
Currant Leaf Spot ...	Acigerous ...	... ...	,, ,, ...	,, ,, ...	533	605
,, ,, ,, ...	,, ...	... ...	*or* Dilute Lime-sulphur	,, ,, ...	533	612
,, ,, ,, ...	,, ...	... ...	*or* Ammonium Polysulphide and Soap ...	,, ,, ...	533	601
,, ,, ,, ...	,, ...	... ...		,, ,, ...	533	452
Die-Back of Gooseberry	... ...	... ...	Copper Sulphate ...	,, ,, ...	547	611
Plum Leaf Rust ...	... ...	... ...	Lime-sulphur ... *or* Bordeaux ...	,, ,, ...	567	612 605

MAY

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Clearwing (Apple) Moth	Pupa ...	Apply sticky composition to bark	... ...	Beginning of month ...	78	
Ermine (small) Moth ...	Caterpillar	Cut out and burn nests	Arsenate of Lead ...	Beginning to middle of month	100	397
Goat Moth	,, ...	... ...	Place lump of Cyanide of Potash in hole and seal	Any time during month	108	423
Gold-Tail Moth ...	,, ...	... ...	Arsenate of Lead ...	,, ,, ,,	112	397
Lackey Moth	,, ...	Destroy tents	... ...	,, ,, ,,	121	
Magpie Moth	,, ...	... ...	Arsenate of Lead ...	,, ,, ,,	134	397
Pith Moth	,, ...	Hand pick dead shoots	... ...	End of month	151	
Tortoiseshell Butterfly	Egg ...	Destroy egg bands ...	... ...	Beginning of month ...	163	
Apple-Blossom Weevil	Grub *or* Pupa	Shake off and burn withered buds	... .	,, ,, ,, ...	190	
Leaf Weevils	Beetle ...	Jar beetles off at night on to sticky boards	... ...	Middle of month ...	196	404
Nut Weevil	,, ...	... ...	Arsenate of Lead ...	Early in month ...	198	397
Raspberry Weevil ...	,, ...	Jar beetles off at night on to sticky boards	... ...	Middle of month ...	202	404
Red-Legged Weevil ..	,, ...	,, ,, ,, ,,	... ...	,, ,, ...	206	404
Twig Cutting Weevil ...	,, ..	Jar off beetles on dull days on to tarred boards	... ...	Beginning of month ...	207	417
Ground Beetles ...	,, ...	Trap in jam jars, sunk in ground and covered with straw	... ...	End of month	214	
Raspberry Beetles ...	,, ...	Jar off on dull days ...	... ...	Middle of month ..	215	
Cockchafer	,, ...	,, ,, ,, ...	Arsenate of Lead ...	Beginning of month ...	222	397
Rose Chafer	,, ...	,, ,, ,, ...	,, ,, ,, ...	,, ,, ,, ...	226	397
Apple Sawfly	Maggot ...	Pick and destroy attacked fruitlets	... ...	Any time during month	237	
Nut Sawfly	,, ...	... ...	Arsenate of Lead ...	On first appearance on leaf	250	397
Plum Fruit Sawfly ...	,, ...	... ...	,, ,, ,, ...	Beginning of month ...	253	397

MAY (continued)

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Plum Leaf Sawfly ...	Maggot ...	... ...	Arsenate of Lead ...	Middle of month ...	256	397
Social Pear Sawfly ...	,, ...	... ...	,, ,, ,, ...	,, ,, ...	258	397
Pear Midge	,, ...	Pick off infected fruit	... ...	Beginning of month ...	263	
Black Cherry Aphis ...	Lice ...	... ...	Soft Soap and Insecticide	Any time during month	290	452
Woolly Aphis	,, ...	... ...	Nicotine Wash ...	Early in month ...	327	436
Apple Sucker	Louse ...	... ...	,, ,, ...	,, ,, ...	337	436
Capsid Bug	Bug ...	... ...	,, ,, ...	End of month	342	436
Apple Bitter Rot ...	Conidial ...	... ...	Bordeaux Spray ...	Every two weeks ...	491	605
,, Brown Rot ...	On fruit ...	Remove infected fruit	... ...	Middle of month ...	497	
,, Leaf Spot ...	Conidial ...	... ...	Summer Strength Bordeaux	Early in month ...	505	605
,, Mildew... ...	,, ...	... ...	Soft Soap and Ammonium Polysulphide	Middle of month ...	507	601
,, Scab	,, ...	... ...	Summer Strength Bordeaux	When leaves show fungus	510	605
,, ,, ...	,, ...	... ...	Summer Strength Lime-sulphur	,, ,, ,, ,,	510	612
Cherry Leaf Curl ...	Spores ...	... ...	Bordeaux Mixture ...	Middle of month ...	521	605
,, Scab	... ...	... ...	As for Apple Scab...	... ...	526	605
,, Witches'-Broom	Spores ...	... ...	Bordeaux Mixture ...	Early in month ...	528	605
Gooseberry Black Knot	Fruit ...	Remove wilting branches	... ...	Any time during month	545	
Pear Leaf Spot ...	Conidial ...	... ...	{ Dilute Bordeaux { ,, Lime-sulphur	Middle of month } ,, ,, } ...	561	{ 605 { 612
Pear Scab	... ...	... ...	See Apple Scab ...	... ...	564	
Plum Leaf Rust ...	... ...	... ...	{ Lime-sulphur } { Bordeaux } ...	End of month	567	{ 612 { 605
Raspberry Rust ...	... ..	... ...	Ammonium Polysulphide	Any time when Rust appears	583	601
Strawberry Leaf Spot	... ...	... ...	Summer Strength Lime-sulphur	Any time during month	587	612

JUNE

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Blister Moth	Caterpillar	Hand pick infested leaves	... ...	Any time during month	58	
Tortoiseshell Butterfly	,,	Destroy young colonies	Arsenate of Lead ...	Early in month ...	164	397
Wood Leopard Moth ...	,,	... ...	Put in piece of Cyanide of Potash and seal	Middle of month ...	181	423
Apple-Blossom Weevil	Beetle ...	Jar on to tarred boards	... ...	Beginning of month	190	417
Leaf Weevils	,, ...	... ...	Arsenate of Lead ...	,, ,,	196	397
Nut Weevils	,, ...	Jar off beetles ...	... ...	,, ,,	198	
Raspberry Weevils ...	,, ...	... ...	Arsenate of Lead ...	,, ,,	202	397
Red-Legged Weevils ...	,, ...	... ...	,, ,, ...	,, ,,	206	397
Gooseberry Sawfly ...	Maggot ...	... ...	Spray with Arsenate of Lead	Any time during month	242	397
			or Spray with Hellebore	... ...		421
			or Spray with Pyrethrum	... ...		444
Slugworm	,, ...	... ...	Spray with Arsenate of Lead *or* Hellebore	Early in month ...	247	397 421
Plum Leaf Sawfly ...	,, ...	Grease band and jar trees	Arsenate of Lead ...	,, ,, ...	256	404 397
Social Pear Sawfly ...	,, ...	Cut and destroy tents	... ...	,, ,, ...	258	
Pear Midge	,, ...	Run fowls over ground	Dress ground with Kainit	,, ,, ...	263	426
Leaf Blister Currant Aphis	Lice ...	... ...	Nicotine Soap wash ...	,, ,, ...	297	436
Hop Aphis	,, ...	... ...	Soft Soap	,, ,, ...	305	452

JUNE (*continued*)

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Mealy Plum Aphis ...	Lice ...	... ...	Soft Soap and Nicotine ...	Early in month ...	317	436
Raspberry Aphis ...	,, ...	... ...	,, ,, ,, ...	,, ,, ...	321	436
Hop Red Spider ...	Spider ...	... ...	Sulphuring	Middle of month ...	375	452
			Soft Soap—Nicotine ...	... ...		
			Liver of Sulphur ...	... ...		
Gooseberry Red Spider	... ...	... ...	A compound wash ...	Anytime during month	377	
Eelworm	... ...	... ...	Soil insecticides ...	,, ,, ,,	383	433
Snails and Slugs ...	... ...	Ducks among plants	,, ,, ...	,, ,, ,,	384	433
,, ,, ...	... ...	... ...	Soot and Lime	,, ,, ,,	384	457 & 428
Apple Leaf Spot ...	Conidial	... ...	Summer strength Bordeaux	Middle of month ...	505	605
Cherry Leaf Scorch ...	,,	... ...	,, ,, ,,	Early in month ...	523	605
Die-back of Gooseberry	,,	... ...	,, ,, ,,	,, ,, ...	547	605
American Gooseberry Mildew	,,	... ...	Lime-sulphur ... ... *or* Ammonium Polysulphide	Anytime during month	539	612 601
European Gooseberry Mildew	,,	... ...	Various, see p. 544 ...	,, ,, ,,	543	544
Hop Mildew	... ...	... ...	Flowers of Sulphur ...	,, ,, ,,	551	
Pear Leaf Spot ...	Conidial	... ...	Dilute Bordeaux ... *or* Dilute Lime-sulphur ...	Middle of month ...	561	605 612
Plum Wither-Tip ...	Mycelium	Remove diseased tips	... ...	Anytime during month	578	

JULY

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Buff-Tip Moth ...	Caterpillar	... ...	Arsenate of Lead ...	End of month ...	69	397
Codling Moth ...	,,	Apply sack bands to trunks	or Grease-bands ...	Early in month ...	88	404
Hawk (Eyed) Moth	,,	Hand pick caterpillars	Arsenate of Lead ...	End of month ..	117	397
Plum Fruit Sawfly ...	Maggot ...	Destroy infected fruit	... ...	Early in month ...	253	
Mussel Scale ...	Lice ...	... ...	Nicotine Soap ... or Paraffin Emulsion	,, ,, ...	355	436 417
Apple Blossom Wilt	On fruit ...	Remove rotten apples	... ...	,, ,, ...	494	
,, Brown Rot ...	On spurs	Cut off infected spurs	... ...	,, ,, ...	497	
Plum Wither-Tip ...	Mycelium	Remove diseased tips	... ...	Middle of month ...	578	

AUGUST

Pest	Stage	Treatment		Time of application	Page reference	
		Preventive	Remedies		Pest	Remedy
Bud Moth	Caterpillar ...	... ...	Arsenate of Lead ...	Any time during month	65	397
Buff-Tip Moth ...	,, ...	Jar off caterpillars ...	Grease band trees ...	End of month	69	404
Clearwing (Currant) Moth	,, ...	Prune off attacked shoots	... ...	Any time during month	81	
Dot Moth	,, ...	Hand pick caterpillars	Arsenate of Lead ...	Early in month ...	96	397
Mottled Umber Moth	Pupa ...	Turn over ground under trees	... ...	Any time during month	143	
Peppered Moth ...	Caterpillar ...	Hand pick caterpillars	Arsenate of Lead ...	,, ,, ,,	147	397
Plum Fruit Moth ...	,, ...	Shake trees and destroy plums which fall	... ...	,, ,, ,,	154	
Nut Weevil	Grub ...	Remove and burn fallen nuts	... ...	,, ,, ,,	198	
Rose Chafer ...	,, ...	Hand pick grubs ...	... ...	Early in month ...	226	
Leaf Hoppers ...	Louse ...	... ...	Nicotine and Soap	Any time during month	350	436
Pear Leaf Spot ...	Acigerous ...	Destroy fallen leaves ...	... ...	,, ,, ,,	561	

SEPTEMBER

Pest	Stage	Treatment		Time of application	Page reference	
		Preventive	Remedies		Pest	Remedy
Case-Bearer Moth ...	Caterpillar ...	... ...	Arsenate of Lead ...	Middle of month ...	74	397
Gold-Tail Moth ...	,, ...	Place sacking around trees	... ...	Early in month ...	112	
Magpie Moth ...	,, ...	... ...	Arsenate of Lead ...	Any time during month	134	397
March Moth ...	Pupa ...	Turn over ground ...	... ...	,, ,, ,,	139	
Plum Fruit Moth ...	Caterpillar ...	Place sacking around trees	*or* apply sticky bands	End of month	154	404
Swift Moth	,, ...	Hoe ground	Apply soil insecticides	Middle of month ...	160	433
Winter Moth ...	... ...	... ...	Grease band trees ...	End of month	176	404
Social Pear Sawfly ...	Maggot ...	... ...	Apply soil insecticides	,, ,, ...	258	433
Black Cherry Aphis	Female and Male	... ...	Soft Soap and Insecticide *or* Paraffin Emulsion	Middle of month ...	290	452, 417
Plum Leaf Curling Moth	Winged female	... ...	Soft Soap and Insecticide	,, ,, ...	313	452
Apple Bitter Rot ...	Acigerous ...	Remove mummified apples, cut out canker on branches	... ...	Any time during month	491	
Apple Canker ...	,, ...	Remove cankered branches	Lime-sulphur ...	Early in month ...	501	612

OCTOBER

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Brown-Tail Moth ...	Caterpillar ...	... ...	Winter strength Lime-sulphur	End of Month	61	430
			or Strong Caustic Soda	... ...		413
Clouded Drab Moth	Pupa... ...	Fowls in orchard...	... ...	All month and succeeding ones	84	
Codling Moth ...	Caterpillar ...	... ...	Lime-sulphur ...	End of month	89	430
Dot Moth	Pupa... ...	Fowls in orchard...	... ...	All month and succeeding ones	96	
Ermine (small) Moth	Caterpillar ...	... ...	Lime-sulphur ...	End of month	100	430
			or Caustic Emulsion...			413
Figure of Eight Moth	Moth... ...	Use light traps ...	... ...	Early in month... ...	105	
Mottled Umber Moth	Moth... ...	... ...	Apply grease bands...	Middle of month ...	143	404
Raspberry Moth ...	Caterpillar ...	Hoe ground ...	Soil insecticides ...	Early in month	157	433
Vapourer Moth ...	Egg	Remove egg masses	... ...	,, ,, ...	172	
Raspberry Weevil ...	Grub... ...	... ...	Hoe in soil insecticides	,, ,, ...	202	433
Cockchafer	Grub... ...	... ...	,, ,, ,,	,, ,, ...	222	433
Gooseberry Sawfly...	Maggot ...	... ...	,, ,, ,,	,, ,, ...	242	433
Slugworm	,, ...	... ...	,, ,, ,,	,, ,, ...	247	433
Social Pear Sawfly...	,, ...	... ...	,, ,, ,,	,, ,, ...	258	433
Blue Apple Aphis ...	Male & female	... ...	Nicotine Soap ...	Middle of month ...	276	436
			or Paraffin Emulsion			417
Green Apple Aphis...	Winged ...	... ...	Nicotine Wash ...	Any time during month...	283	436
Apple Sucker ...	,, ...	... ...	Nicotine Wash ...	,, ,, ,, ...	337	436
			or Paraffin Emulsion	... ...		417

NOVEMBER

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Blister Moth ...	Pupa ...	... ...	Lime-sulphur ...	End of month	58	430
Lackey Moth ...	Eggs ...	Remove branches with eggs	... ...	Any time during month	121	
Plum Fruit Moth	Caterpillar	... ...	Lime-sulphur ...	,, ,, ,,	154	430
Raspberry Beetle	Pupa ...	Prune canes and destroy cuttings	... ...	,, ,, ,,	215	

DECEMBER

Pest	Stage	Treatment: Preventive	Treatment: Remedies	Time of application	Page reference: Pest	Page reference: Remedy
Pith Moth ...	Caterpillar	Prune off attacked shoots	... ...	Any time during month	151	
Raspberry Beetle	Pupa ...	Hoe in Soot or Lime ...	... ...	,, ,, ,,	215	427, 428
Shot-Borer Beetle	Beetle ...	Cut down and burn attacked trees	... ...	,, ,, ,,	219	

SECTION XI

TABLES AND APPENDICES

TABLE I

WEIGHTS AND MEASURES IN COMMON USE

WEIGHTS (English)

1 ounce = $437\frac{1}{2}$ grains = 28·35 grammes.

1 pound (lb.) = 16 ounces (oz.) = 7000 grains = 453·6 grammes, or 0·454 kilogramme.

1 hundred weight (cwt.) = 4 quarters (qr.) = 8 stones = 112 lbs. = 50·80 kilogrammes.

1 ton = 20 cwt. = 2240 lbs. = 1016·65 kilogrammes.

WEIGHTS (American)

As for English, but tons are usually "short" tons of 2000 lbs. = 0·892 of an English ton.

WEIGHTS (Metric)

1 gramme (g.) = 15·432 grains.

1 kilogramme (kg.) = 1000 g. = 2·2046 lbs.

1 metrical ton = 1000 kg. = 0·9842 English ton = 1·023 American tons (of 2000 lbs.).

1 cubic foot of water = 62·5 lbs. (nearly).

1 cwt. of water occupies 1·79 cu. feet.

1 ton of water occupies 35·7 cu. feet.

MEASURES (English)

1 fluid ounce = $\frac{1}{20}$ pint = 1·733 cu. inches = 28·35 cubic centimetres.

1 pint = 20 ozs. = 34·66 cu. inches = 567 cubic centimetres.

1 quart = $\frac{1}{4}$ gallon = 2 pints = 40 ozs. = $2\frac{1}{2}$ lbs. water.

1 gallon = 4 quarts = 10 lbs. of water = 70,000 grains = 4·536 litres (kilogrammes water) = 277·28 cu. inches.

1 peck = 2 gallons = 20 lbs. water.

1 bushel = 4 pecks = 8 gallons.

1 quarter = 8 bushels = 32 pecks = 64 gallons.

MEASURES (American)

As for English but U.S. gallon = 8·345 lbs. water = 3·7854 litres

MEASURES (Metric)

1 litre = 1000 cubic centimetres = 0·2201 English gallon.

TABLE II

Amounts of solid or liquid substances to be taken to obtain 1,000,000 gallons of wash of different percentage strengths.

(Divide by specific gravity to obtain liquids in measured ounces)

Percentage Strength	In 1 gallon				In 10 gallons				In 100 gallons			
	ozs.				ozs.				ozs.			
0·0156	—				$\frac{1}{4}$				$2\frac{1}{2}$			
0·0313	—				$\frac{1}{2}$				5			
0·0625	—				1				10			
0·094	—				$1\frac{1}{2}$				15			
0·100	—				$1\frac{3}{5}$				16			
									lbs.	ozs.	pts.	ozs.
0·125	—				2				1	4	1	0
0·157	$\frac{1}{4}$				$2\frac{1}{2}$				1	9	1	5
0·188	$\frac{3}{10}$				3				1	14	1	10
0·20	$\frac{1}{3}$				$3\frac{1}{5}$				2	0	1	12
0·25	$\frac{2}{5}$				4				2	8	2	0
0·31	$\frac{1}{2}$				5				3	2	2	10
0·38	$\frac{3}{5}$				6				3	12	3	0
0·50	$\frac{4}{5}$				8				5	0	4	0
0·63	1				10				6	4	5	0
0·75	$1\frac{1}{5}$				12				7	8	6	0
0·88	$1\frac{2}{5}$				14				8	12	7	0
											galls.	pts.
1·00	$1\frac{3}{10}$				16				10	0	1	0
					lbs.	ozs.	pts.	ozs.				
1·25	2				1	4	1	0	12	8	1	2
1·50	$2\frac{2}{5}$				1	8	1	4	15	0	1	4
1·88	3				1	14	1	10	18	12	1	7
2·00	$3\frac{1}{5}$				2	0	1	12	20	0	2	0
2·50	4				2	8	2	0	25	0	2	4
3·00	$4\frac{4}{5}$				3	0	2	8	30	0	3	0
3·75	6				3	12	3	0	37	8	3	12
5	8				5	0	4	0	50	0	5	0
6	$9\frac{1}{2}$				6	0	4	16	60	0	6	0
10	16				10	0	8	0	100	0	10	0
	lbs.	ozs.	pts.	ozs.								
15	1	8	1	4	15	0	12	0	150	0	15	0
20	2	0	1	12	20	0	16	0	200	0	20	0

TABLE III

TO FIND THE CAPACITY OF A TANK, ETC.

To find the capacity of a *square or oblong tank*, multiply the length by the width in feet, and the result by the height in feet, and multiply this figure by $6\frac{1}{4}$ (6·25). This gives the capacity in gallons.

If the weight is required, this is obtained in lbs. by multiplying the number of gallons by 10 (if the liquid is water or the same specific gravity) or by 10 times the specific gravity if not the same as water.

Or the capacity in gallons may be divided by 11·2 giving the result in cwts.

If the tank is *cylindrical*, the following table may be used. This shows the capacities for a tank 1 foot in length and various diameters. To obtain the capacity for other heights, multiply the figure opposite the correct diameter by the height of the vessel.

Diameter ft.	Capacity in gallons	Weight of water
1	4·9	49 lbs.
2	19·7	1 cwt. 85 lbs.
3	44·0	3 cwts. 104 lbs.
4	78·1	6 cwts. 109 lbs.
5	123	10 cwts. 110 lbs.
6	176	15 cwts. 80 lbs.
7	240	1 ton $1\frac{1}{2}$ cwts.
8	328	1 ton $9\frac{1}{4}$ cwts.
9	396	1 ton $15\frac{1}{2}$ cwts.
10	491	2 tons $2\frac{3}{4}$ cwts.
11	597	2 tons $13\frac{1}{4}$ cwts.
12	709	3 tons $3\frac{1}{4}$ cwts.

TABLE IV

WEIGHTS OF COMMON METALS

The following are the weights of one square foot of Metal Sheet of various thicknesses:

Thickness	Wrought Iron	Cast Iron	Steel	Copper	Brass	Lead	Zinc
inch	lb.	lb.	lb.	lb.	lb.	lb.	lb.
$\frac{1}{16}$	2·53	2·34	2·55	2·89	2·73	3·71	2·34
$\frac{1}{8}$	5·05	4·69	5·10	5·78	5·47	7·42	4·69
$\frac{3}{16}$	7·58	7·03	7·66	8·67	8·20	11·13	7·03
$\frac{1}{4}$	10·10	9·38	10·21	11·76	10·94	14·83	9·38
$\frac{5}{16}$	12·63	11·72	12·76	14·45	13·67	18·54	11·72
$\frac{3}{8}$	15·16	14·06	15·31	17·34	16·41	22·25	14·06
$\frac{7}{16}$	17·68	16·41	17·87	20·23	19·14	25·96	16·41
$\frac{1}{2}$	20·21	18·75	20·42	23·13	21·88	29·67	18·75
$\frac{9}{16}$	22·73	21·09	22·97	26·02	24·61	33·38	21·09
$\frac{5}{8}$	25·27	23·44	25·52	28 91	27·34	37·08	23·44
$\frac{11}{16}$	27·79	25·78	28·07	31·80	30·08	40·79	25·78
$\frac{3}{4}$	30·31	28·13	30·63	34·69	32·81	44·50	28·13
$\frac{13}{16}$	32·84	30·47	33·18	37·58	35·55	48·21	30·47
$\frac{7}{8}$	35·87	32·81	35·73	40·47	38·28	51·92	32·81
$\frac{15}{16}$	37·90	35·16	38·28	43·36	41·02	55·63	35·16
1	40·42	37·50	40·83	46·25	43·75	59·33	37·50

APPENDIX I

CALENDAR OF INSECT PESTS

These diagrams are summaries of the calendars given at the end of each description on insect pests, and show the approximate duration of each stage of the insect. They will repay careful study.

Incidentally they show how very varied is the life-history of the pests concerned. It will be seen, for instance, that the winter is passed by many insects in the larval stage (caterpillar, grub, etc.), but many also hibernate in the pupal stage, a few in the egg stage, and one or two winter as adults, sheltered in more or less secure retreats.

BUD	Bud Moth
BL	Blister
BT	Brown-Tail
BF	Buff-Tip
CB	Case-bearers
ACW	Apple Clearwing
CCW	Currant Clearwing
CD	Clouded Drab
C	Codling
DE	December
DO	Dot
E	Ermine (small)
F	Figure of Eight
G	Goat
GT	Gold-Tail
H	Hawk
L	Lackey
LP	Lappet
LM	Leaf Miner
M	Magpie
MR	March
MU	Mottled Umber
PP	Peppered
PT	Pith
PF	Plum Fruit
R	Raspberry
S	Swift
T	Tortoiseshell
TX	Tortrix
V	Vapourer
W	Winter
WL	Wood Leopard
ABW	Apple Blossom Weevil
NW	Nut Weevil
RW	Raspberry Weevil
RB	Raspberry Beetle
SB	Shot-borer Beetle
CK	Cockchafer
RC	Rose Chafer
AS	Apple Sawfly
GCS	Gooseberry & Currant Sawfly
SW	Slug Worm
NS	Nut Sawfly
PFS	Plum Fruit Sawfly
SPS	Social Pear Sawfly
PM	Pear Midge

Duration of Egg Stage of Insects

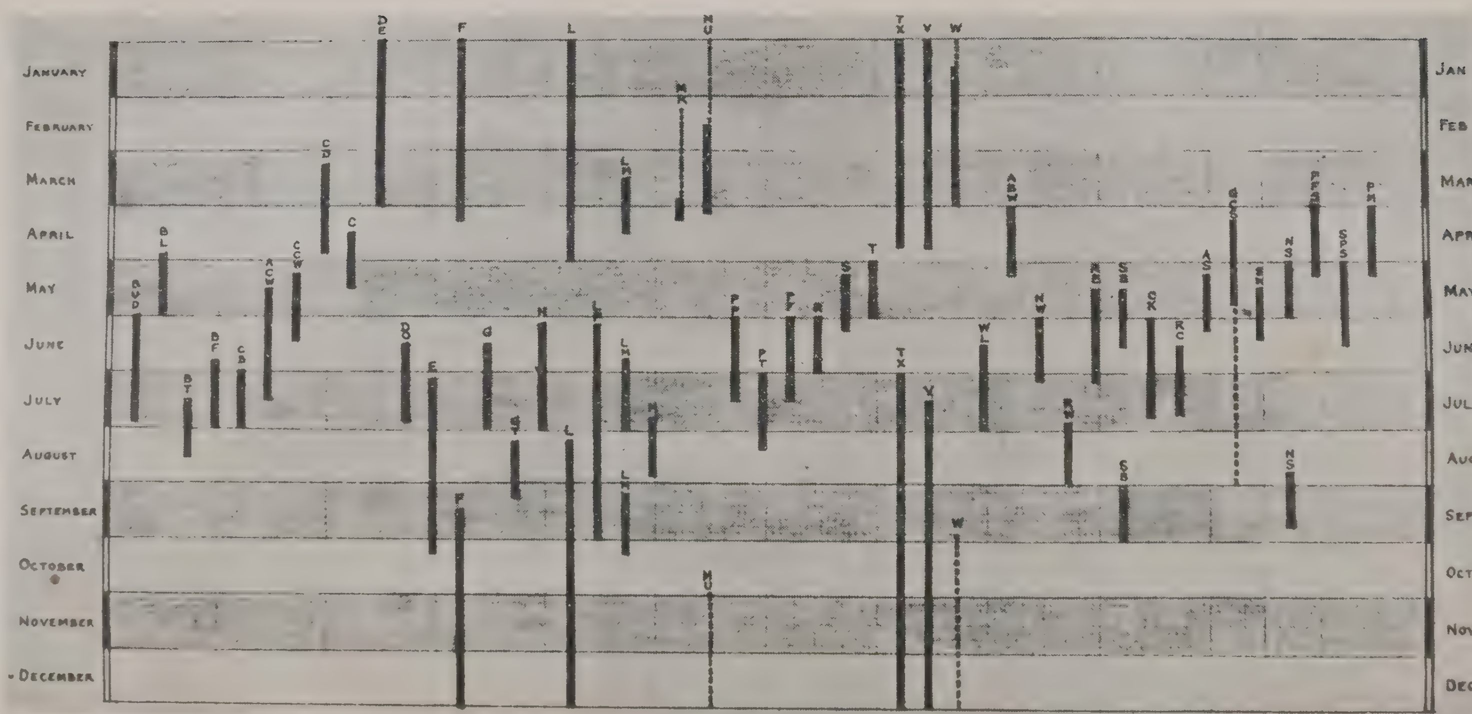


Fig. 289.

BUD	Bud Moth	F	Figure of Eight	PF	Plum Fruit	SB	Shot-borer Beetle
BL	Blister	G	Goat	R	Raspberry	CK	Cockchafer
BT	Brown-Tail	GT	Gold-Tail	S	Swift	RC	Rose Chafer
BF	Buff-Tip	H	Hawk	T	Tortoiseshell	AS	Apple Sawfly
CB	Case-bearers	L	Lackey	TX	Tortrix	GCS	Gooseberry & Currant Sawfly
ACW	Apple Clearwing	LP	Lappet	V	Vapourer		
CCW	Currant Clearwing	LM	Leaf Miner	W	Winter	SW	Slug Worm
CD	Clouded Drab	M	Magpie	WL	Wood Leopard	NS	Nut Sawfly
C	Codling	MR	March	ABW	Apple Blossom Weevil	PFS	Plum Fruit Sawfly
DE	December	MU	Mottled Umber	NW	Nut Weevil	SPS	Social Pear Sawfly
DO	Dot	PP	Peppered	RW	Raspberry Weevil	PM	Pear Midge
	Ermine (small)	PT	Pith	RB	Raspberry Beetle		

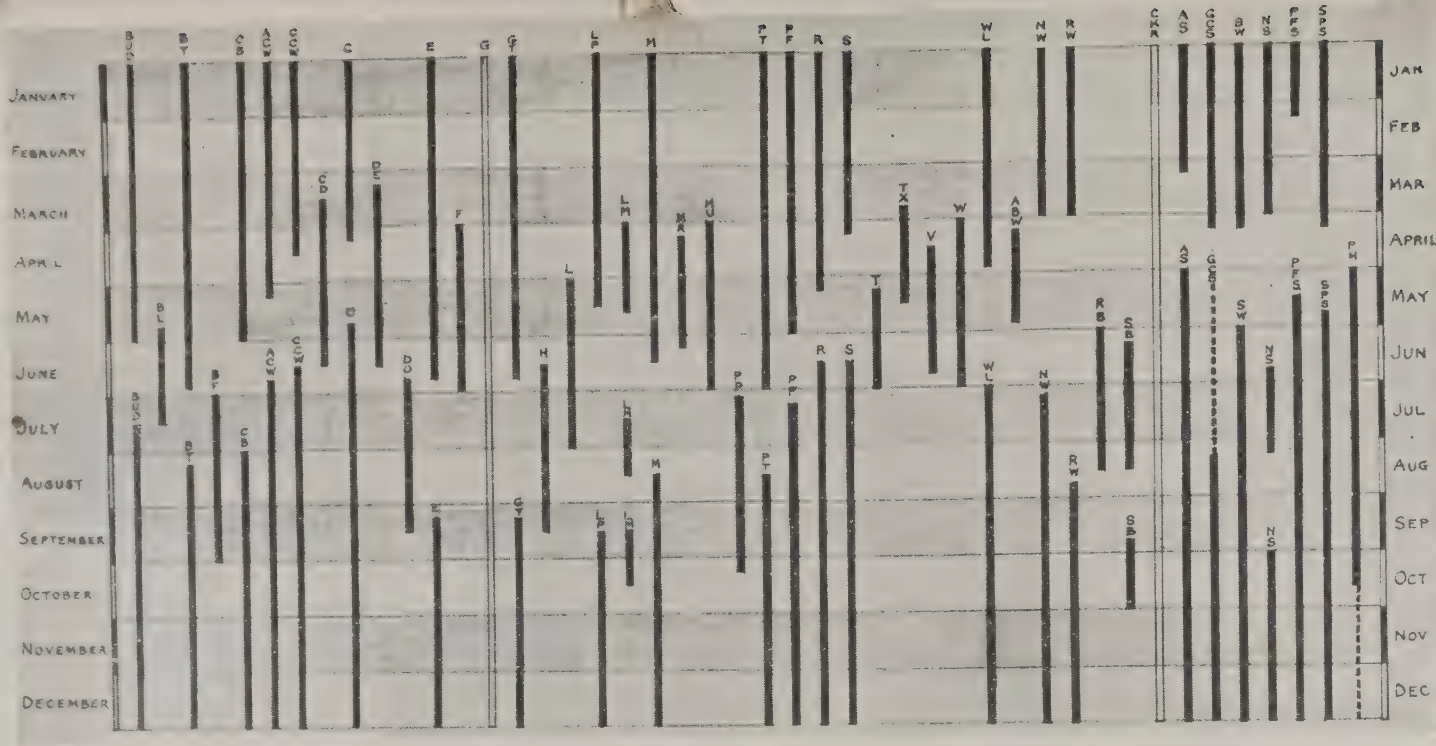


Fig. 290.

BUD	Bud Moth	F	Figure of Eight	PF	Plum Fruit	SB	Shot-borer Beetle
BL	Blister	G	Goat	R	Raspberry	CK	Cockchafer
BT	Brown-Tail	GT	Gold-Tail	S	Swift	RC	Rose Chafer
BF	Buff-Tip	H	Hawk	T	Tortoiseshell	AS	Apple Sawfly
CB	Case-bearers	L	Lackey	TX	Tortrix	GCS	Gooseberry & Currant Sawfly
ACW	Apple Clearwing	LP	Lappet	V	Vapourer	SW	Slug Worm
CCW	Currant Clearwing	LM	Leaf Miner	W	Winter	NS	Nut Sawfly
CD	Clouded Drab	M	Magpie	WL	Wood Leopard	PFS	Plum Fruit Sawfly
C	Codling	MR	March	ABW	Apple Blossom Weevil	SPS	Social Pear Sawfly
DE	December	MU	Mottled Umber	NW	Nut Weevil	PM	Pear Midge
DO	Dot	PP	Peppered	RW	Raspberry Weevil		
E	Ermine (small	PT	Pith	RB	Raspberry Beetle		

Duration of the Pupa Stage of Insects

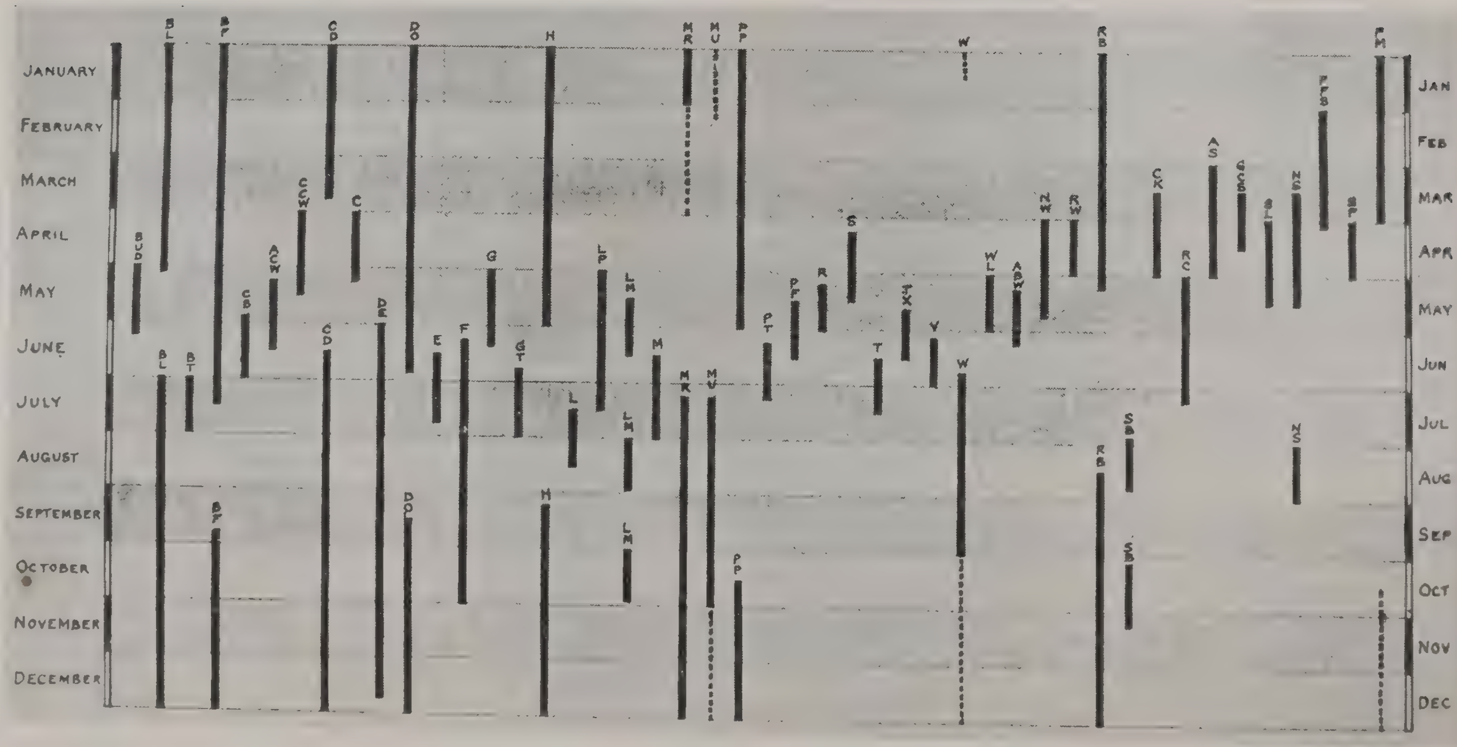


Fig. 291.

BUD	Bud Moth	F	Figure of Eight	PF	Plum Fruit	SB	Shot-borer Beetle
BL	Blister	G	Goat	R	Raspberry	CK	Cockchafer
BT	Brown-Tail	GT	Gold-Tail	S	Swift	RC	Rose Chafer
BF	Buff-Tip	H	Hawk	T	Tortoiseshell	AS	Apple Sawfly
CB	Case-bearers	L	Lackey	TX	Tortrix	GCS	Gooseberry & Currant Sawfly
ACW	Apple Clearwing	LP	Lappet	V	Vapourer	SW	Slug Worm
CCW	Currant Clearwing	LM	Leaf Miner	W	Winter	NS	Nut Sawfly
CD	Clouded Drab	M	Magpie	WL	Wood Leopard	PFS	Plum Fruit Sawfly
C	Codling	MR	March	ABW	Apple Blossom Weevil	SPS	Social Pear Sawfly
DE	December	MU	Mottled Umber	NW	Nut Weevil		
DO	Dot	PP	[illegible]				

Duration of the Adult Stage of Insects

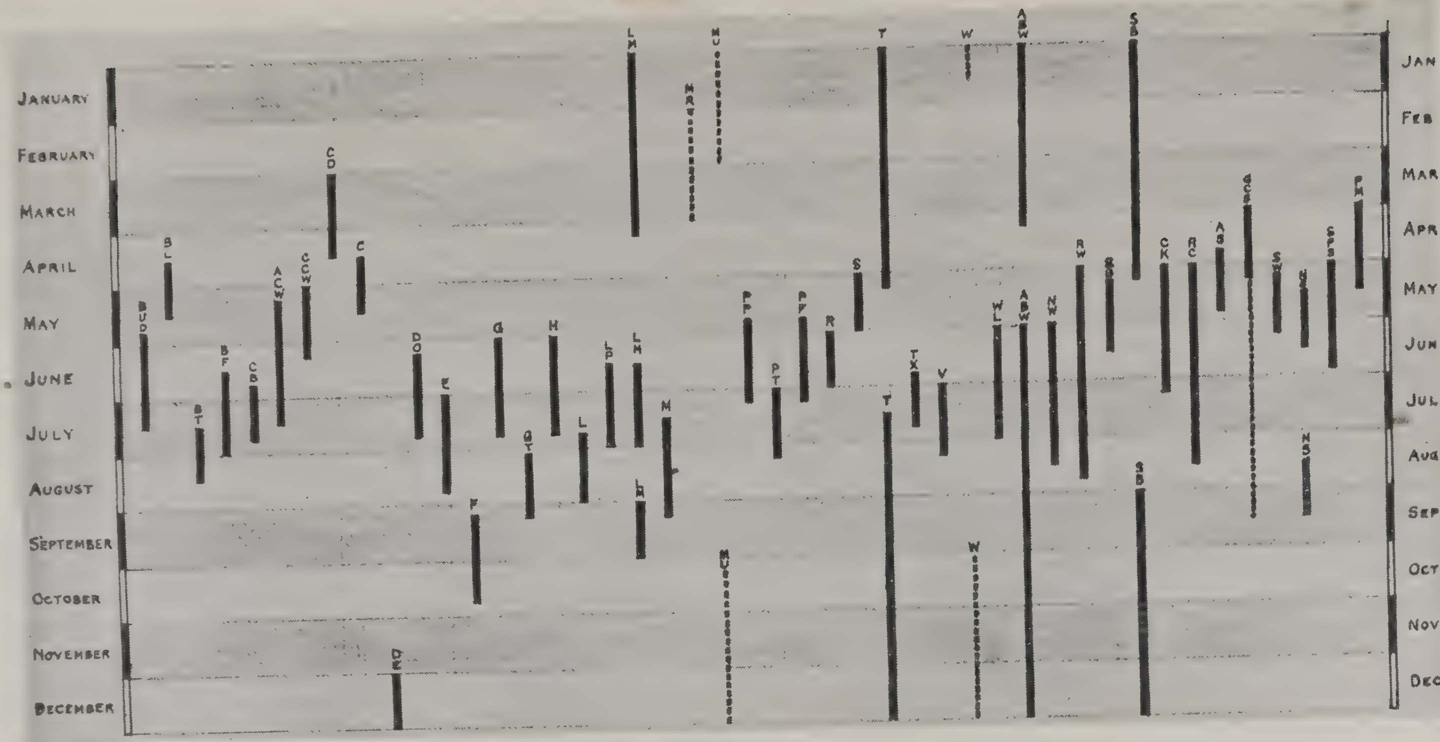


Fig. 292.

BUD	Bud Moth	F	Figure of Eight	PF	Plum Fruit	SB	Shot-borer Beetle
BL	Blister	G	Goat	R	Raspberry	CK	Cockchafer
BT	Brown-Tail	GT	Gold-Tail	S	Swift	RC	Rose Chafer
BF	Buff-Tip	H	Hawk	T	Tortoiseshell	AS	Apple Sawfly
CB	Case-bearers	L	Lackey	TX	Tortrix	GCS	Gooseberry & Currant Sawfly
ACW	Apple Clearwing	LP	Lappet	V	Vapourer	SW	Slug Worm
CCW	Currant Clearwing	LM	Leaf Miner	W	Winter	NS	Nut Sawfly
CD	Clouded Drab	M	Magpie	WL	Wood Leopard	PFS	Plum Fruit Sawfly
C	Codling	MR	March	ABW	Apple Blossom Weevil	SPS	Social Pear Sawfly
DE	December	MU	Mottled Umber	NW	Nut Weevil	PM	Pear Midge
DO	Dot	PP	Peppered	RW	Raspberry Weevil		
E	Ermine (small)	PT	Pith	RB	Raspberry Beetle		

APPENDIX II

THE GIPSY MOTH

Ocneria (Lymantia) dispar

This is not a pest in England, but has caused an enormous amount of damage in the States.

It was introduced into Massachusetts about the year 1868, and has cost many thousands of dollars to keep it in check. In 1891, a commission was established for its extermination, and the reports issued make interesting reading. It is perhaps the most dangerous pest ever introduced into the States, and unless the present campaign against it is maintained, it will threaten the entire crops of the country. The caterpillar feeds upon an enormous number of different plants, and is especially difficult to control.

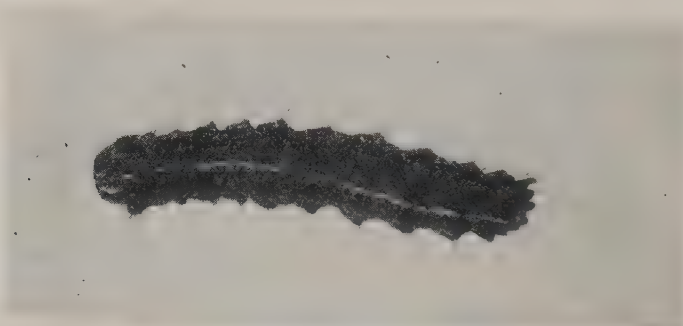


Fig. 293. Caterpillar of the Gipsy Moth. Natural size.

The adult insect is shown in fig. 295. The females are much larger and of stouter build than the males. They are creamy white in colour with irregular transverse lines of grey.

The eggs are laid in masses of 400—500 in a great diversity of situations, and are covered with yellow hair and scales from the abdomen. They are found in July onwards until late in September, and remain throughout the winter, the caterpillars hatching out early the following year (April—June).

The caterpillar (fig. 293) is about $1\frac{1}{2}$ inches long when mature and is of cream colour, so thickly spotted with black as to appear brown in tint. There is a broken cream line along the middle of the body, and long tufts of hairs project from each segment. It pupates during July and September, forming a chocolate brown pupa (see fig. 294)

with a very incomplete cocoon, which serves to hold it in place. The moths emerge in a few days.

The remedies adopted are:—

1. Spraying the plants in spring and summer with Arsenate of Lead to kill the caterpillars.
2. Hunting out and destroying the egg masses during the autumn and winter.

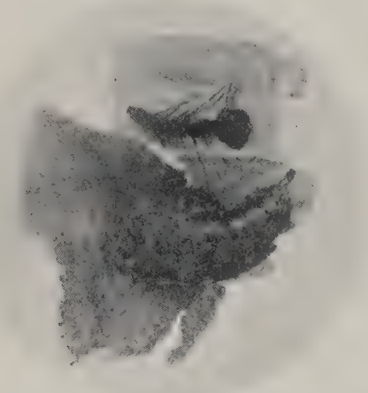


Fig. 294. Pupa of the Gipsy Moth with shrivelled larva skin. Natural size.

Fig. 295. Male (above) and female (below) of Gipsy Moth. Natural size

APPENDIX III

THE STRUCTURE OF INSECTS

The subjoined figure is from a photograph of a wasp (*Vespa crabro*) belonging to the family Hymenoptera, carefully dissected to show clearly the various parts of the body. The Cockchafer (*Melolontha vulgaris*), family Coleoptera, is shown similarly dissected in fig. 297. In each case the insect is shown complete, viewed from above and below. In the centre is a complete dissection of the body parts, while on the right the leg parts are shown separated from one another.

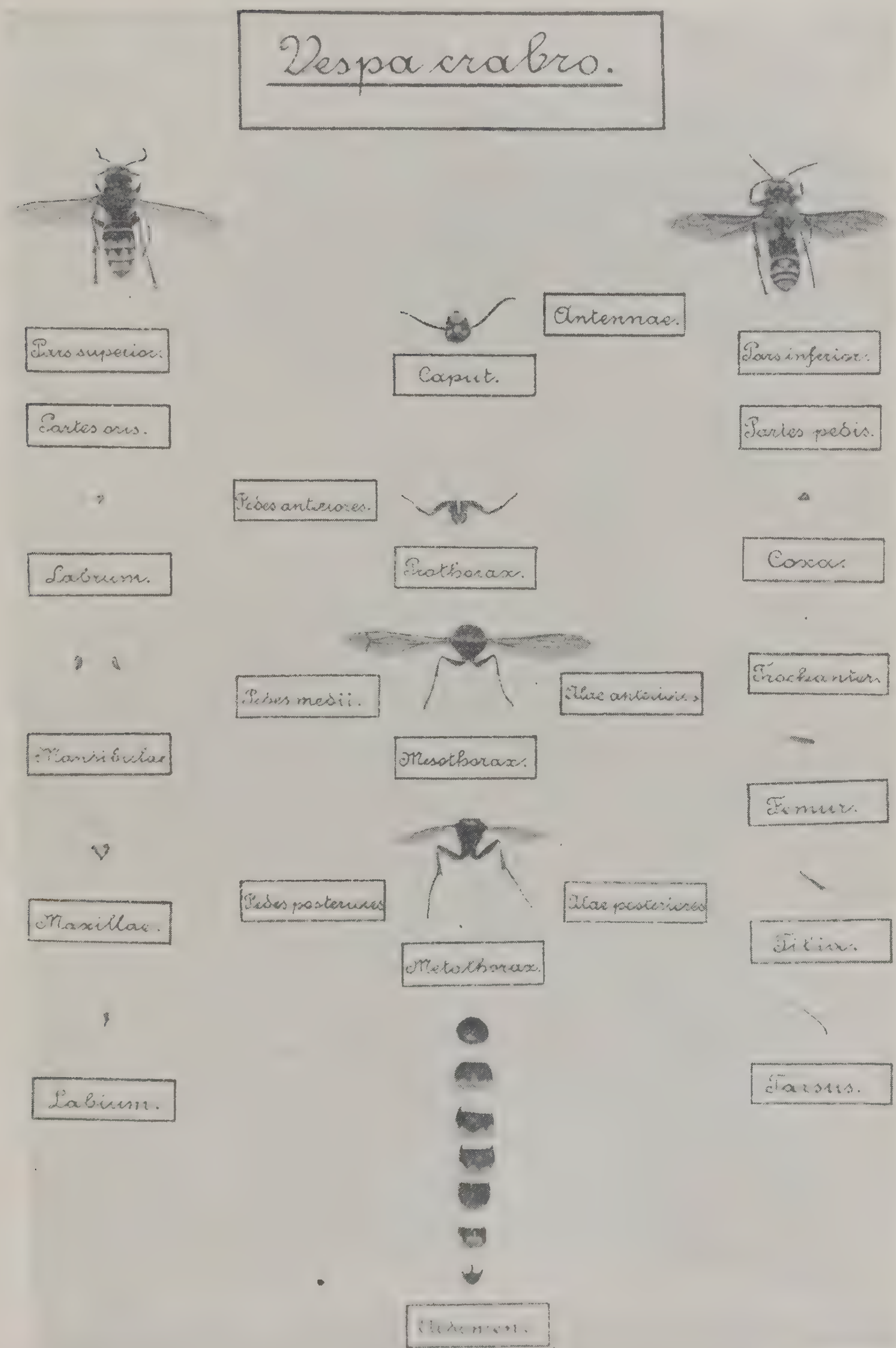


Fig. 296. The Common Wasp carefully dissected to show all the body parts.

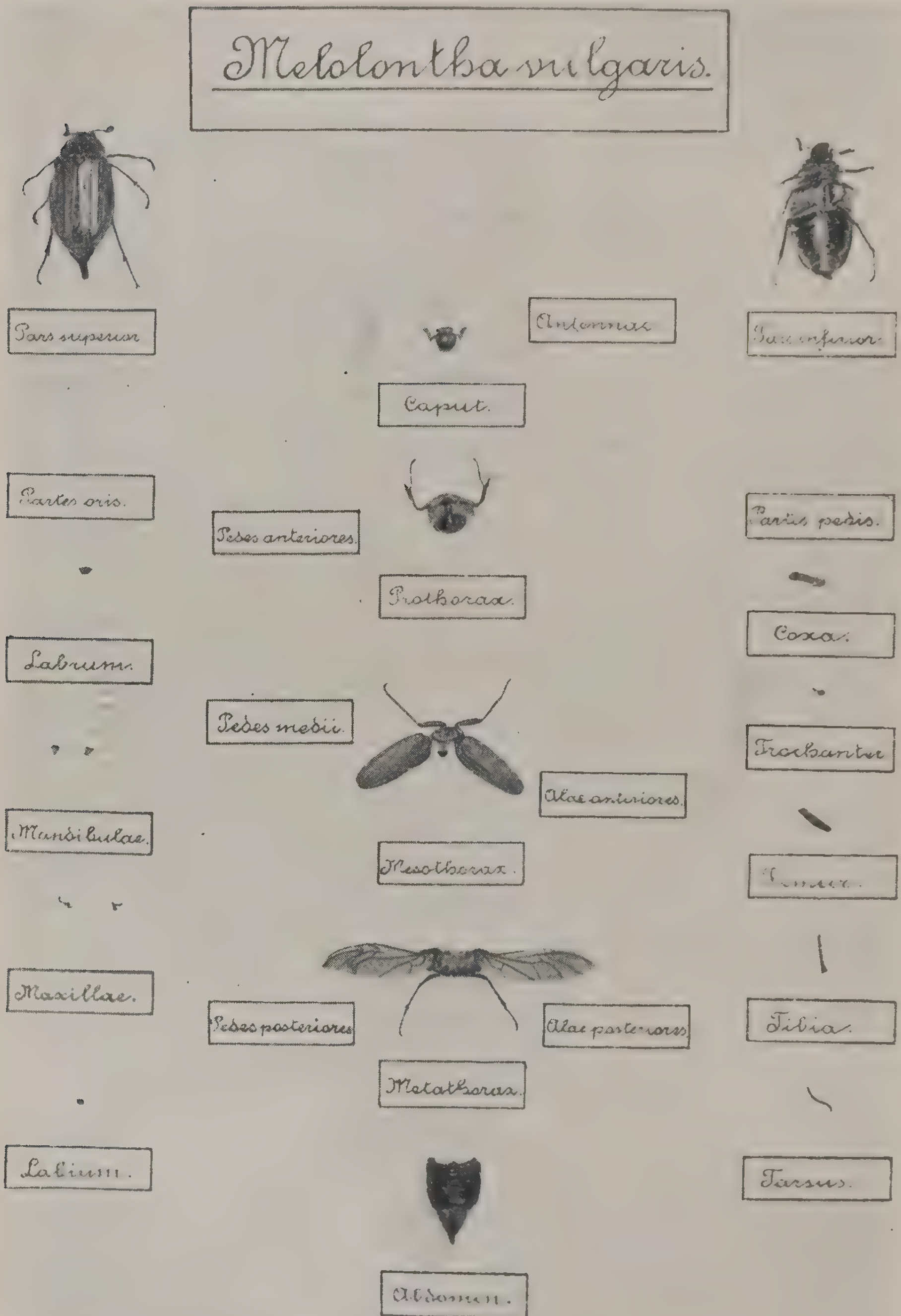


Fig. 297. The Cockchafer Beetle dissected to show the body parts.

APPENDIX IV

"THE HOP DOG"

Dasychira (Orygia) pudibunda

This very hairy caterpillar has been found on hops from time to time, but is seldom a serious pest. It was reported in Herefordshire as attacking apples to a serious extent in 1913.

Fig. 298. Caterpillar of "Hop Dog," *Dasychira pudibunda*. Natural size.

The moth generally appears in May and June, but frequently occurs earlier. Eggs are laid in groups of about 50. The caterpillars are found from July to October. They are about $1\frac{1}{2}$ to 2 inches in length when mature.

APPENDIX V

REFRACTIVE INDICES OF AQUEOUS SOLUTIONS OF NICOTINE (FRYER)

Per Cent. Nicotine	Refractive Index, 15° C.	Differ-ence	Per Cent. Nicotine	Refractive Index, 15° C.	Differ-ence	Per Cent. Nicotine	Refractive Index, 15° C.	Differ-ence	Per Cent. Nicotine	Refractive Index 15° C.	Differ-ence
100	1·5300	7	74	1·4932	18	48	1·4369	22	22	1·3803	21
99	1·5293	8	73	1·4913	19	47	1·4347	22	21	1·3781	22
98	1·5285	9	72	1·4893	20	46	1·4325	22	20	1·3760	21
97	1·5276	10	71	1·4873	20	45	1·4303	22	19	1·3738	22
96	1·5266	11	70	1·4852	21	44	1·4281	22	18	1·3717	21
95	1·5255	11	69	1·4831	21	43	1·4259	22	17	1·3695	22
94	1·5244	12	68	1·4809	22	42	1·4237	22	16	1·3674	21
93	1·5232	13	67	1·4787	22	41	1·4215	22	15	1·3652	22
92	1·5219	13	66	1·4765	22	40	1·4193	22	14	1·3631	21
91	1·5206	13	65	1·4743	22	39	1·4171	22	13	1·3609	22
90	1·5193	14	64	1·4721	22	38	1·4149	22	12	1·3588	21
89	1·5179	14	63	1·4699	22	37	1·4127	22	11	1·3567	21
88	1·5165	15	62	1·4677	22	36	1·4105	22	10	1·3546	21
87	1·5150	16	61	1·4655	22	35	1·4083	22	9	1·3525	21
86	1·5134	16	60	1·4633	22	34	1·4061	22	8	1·3504	21
85	1·5118	16	59	1·4511	22	33	1·4039	21	7	1·3483	21
84	1·5102	16	58	1·4589	22	32	1·4018	22	6	1·3463	20
83	1·5086	17	57	1·4567	22	31	1·3997	21	5	1·3443	20
82	1·5069	17	56	1·4545	22	30	1·3976	22	4	1·3422	21
81	1·5052	17	55	1·4523	22	29	1·3954	21	3	1·3402	20
80	1·5035	17	54	1·4501	22	28	1·3933	22	2	1·3382	20
79	1·5018	17	53	1·4479	22	27	1·3911	22	1	1·3362	20
78	1·5001	17	52	1·4457	22	26	1·3889	21	0	1·3341	21
77	1·4984	17	51	1·4435	22	25	1·3868	22			
76	1·4967	17	50	1·4413	22	24	1·3846	22			
75	1·4950	18	49	1·4391	22	23	1·3824	21			

REFRACTIVE INDICES OF AQUEOUS SOLUTIONS OF PYRIDINE (FRYER)

Per Cent. Pyridine	Refractive Index, 15° C.	Difference	Per Cent. Pyridine	Refractive Index, 15° C.	Difference	Per Cent. Pyridine	Refractive Index, 15° C.	Difference	Per Cent. Pyridine	Refractive Index, 15° C.	Difference
					17			20			20
100	1·5136	8	74	1·4782	18	48	1·4277	19	22	1·3770	20
99	1·5128	9	73	1·4764	18	47	1·4258	19	21	1·3750	19
98	1·5119	10	72	1·4746	18	46	1·4239	20	20	1·3731	19
97	1·5109	10	71	1·4728	18	45	1·4219	19	19	1·3712	20
96	1·5099	11	70	1·4710	18	44	1·4200	19	18	1·3692	20
95	1·5088	11	69	1·4792	19	43	1·4181	19	17	1·3672	20
94	1·5077	12	68	1·4673	19	42	1·4162	20	16	1·3652	20
93	1·5065	12	67	1·4654	19	41	1·4142	19	15	1·3632	20
92	1·5053	12	66	1·4635	19	40	1·4123	20	14	1·3612	20
91	1·5041	13	65	1·4616	19	39	1·4103	19	13	1·3592	20
90	1·5028	13	64	1·4597	20	38	1·4084	20	12	1·3572	20
89	1·5015	13	63	1·4577	20	37	1·4064	19	11	1·3552	20
88	1·5002	14	62	1·4557	20	36	1·4045	20	10	1·3532	20
87	1·4988	14	61	1·4537	21	35	1·4025	20	9	1·3512	20
86	1·4974	14	60	1·4516	20	34	1·4005	19	8	1·3492	19
85	1·4960	15	59	1·4496	21	33	1·3986	20	7	1·3473	19
84	1·4945	15	58	1·4475	21	32	1·3966	19	6	1·3454	19
83	1·4930	15	57	1·4454	20	31	1·3947	20	5	1·3435	19
82	1·4915	15	56	1·4434	20	30	1·3927	20	4	1·3416	19
81	1·4900	16	55	1·4414	20	29	1·3907	19	3	1·3397	19
80	1·4884	17	54	1·4394	19	28	1·3888	20	2	1·3378	19
79	1·4867	17	53	1·4375	19	27	1·3868	19	1	1·3359	18
78	1·4850	17	52	1·4356	19	26	1·3849	20	0	1·3341	
77	1·4833	17	51	1·4337	20	25	1·3829	20			
76	1·4816	17	50	1·4317	20	24	1·3809	19			
75	1·4799	17	49	1·4297	20	23	1·3790	20			

APPENDIX VI

"REVERSION," "GOING WILD" OR "NETTLE HEAD OF CURRANTS"

For a good number of years now it has been noticed that in certain plantations the foliage of currants, especially black currants, has undergone a curious modification. This consists of the growth of narrow pointed leaves, more "saw-toothed" than normal (see fig. 299). Together

Fig. 299.

with this alteration in the character of the leaf, there usually occurs a great increase in the numbers of lateral shoots. Of late years this trouble has been on the increase, and is now apparently responsible for as much damage as the "big bud" disease. In many cases "reversion" is associated with the latter disease, but in many others there is no evidence of its presence at all. Thus it is open to grave doubt whether big bud has any action in causing reversion—indeed, the opposite

might be the case, and the mite attack be consequent upon the reversion.

In many cases abnormal growth of laterals was shown to be the result of the injury to the terminal bud. It is now proved, however, that even cutting off the terminal bud does not produce reversion. Experiments are now being undertaken to secure mite-free reverted stock and to investigate the whole subject. This work is being undertaken by Professor Lees at Bristol.

APPENDIX VII

ARSENIC POISONING

If arsenic compounds have been taken into the mouth, the following mixture is very valuable. It is well for all users of arsenic compounds to prepare a quantity of this, enough for a few doses in case of emergency (a still better antidote may be bought at any druggist's stores under the name of "liquor ferri dialysate"—dose 10—30 minims).

Take 4 parts of ferric sulphate solution (liquor ferri persulphatis B.P.) and mix with 12½ parts of water, keep in a stoppered bottle. Rub one part of magnesia with cold water to a thin smooth cream, dilute to 75 parts and transfer to another stoppered bottle. When required for use, shake the magnesia up well, and add gradually to the ferrous sulphate, shaking at intervals. Dose is 4 fluid ounces.

After either of these has been administered, the stomach must be emptied and stimulants and warmth applied. In any case, lose no time in calling in medical aid.

APPENDIX VIII

POWDER ("DRY") SPRAYING

The figure shows a new method of powder spraying, using a portable air compressor and special powder distributor. Powder spray has been employed to a considerable extent in the United States, and while in some cases it has proved equally as effective as wet spraying, it is, on the average, much less efficient, while the costs are about the same. It is therefore unlikely to displace wet spraying, except where suitable water is not available, or in very hilly districts, where water carriage is difficult.

The most popular powder mixture for dry spraying is composed of about 85 parts of sulphur (pure sulphur, dried lime-sulphur or similar substance) and the remainder Arsenate of Lead. Mixtures of Bordeaux Powder and Arsenates (Lead or Calcium) are also used with or without a diluent such as chalk powder.

Fig. 300. Powder spraying by means of portable air-compressor.

APPENDIX IX

THE USE OF BENEFICIAL INSECTS IN COMBATING INSECT PESTS

The artificial use of beneficial insects by collection or propagation for pest-destruction has not, as far as the author is aware, been tried to any extent in this country. In America, however, this method has been used in several instances with conspicuous success. It is mainly applicable in the case of insect pests imported from other countries. Frequently such pests increase in their new surroundings at an alarming rate, which is due to the fact that the natural enemies of the insect, which are sufficient to keep it in check in its native country, are absent. The remedy is to discover the identity of these "beneficial" insects, and to introduce them in the areas affected.

One well-known instance of this was the case of the "Fluted scale." The orange growers of California were attacked very severely with this pest, which threatened to ruin the industry. The then entomologist to the U. S. Department of Agriculture (C. V. Riley) traced the origin of this pest to Australia. In 1888 an entomologist was sent to discover the natural enemies of the pest in Australia. As a result the lady-bird beetle, known as *Vedalia cardinalis*, was collected and brought over to California and distributed to growers. In less than 18 months the beetles had practically rid the country of the pest.

In other districts the localities where lady-birds hibernate are noted (usually in the mountains), and they are collected in large quantities in the winter, kept in cold storage, and sent in boxes of several thousands to growers when attacks of aphis grow serious.

Although the concentration of certain fruit in definite areas is of great assistance to such a method in America, while in England the scattered orchards offer less favourable conditions, it might be well worth while to make experiments in this direction.

Besides enemies of their own class, many insect pests are subject to bacterial and fungoid diseases which are very contagious and rapidly fatal. It might be possible to propagate suitable bacteria and fungi and produce infection of the pest by spraying cultures of these, or in other ways. Even in America such methods are only in their infancy, and there is a large field open for future research.

APPENDIX X

CHERRY AND PLUM LEAF BLIGHT

(*Cylindrosporium padi*)

This disease appears to be slightly on the increase, especially in the United States. It occurs mainly on young stock. The disease appears in late spring, as pale spots on the leaves, sometimes with a reddish tint. The diseased areas spread and the attacked portion dies and falls out, leaving holes in the leaves. Severe attacks cause a leaf-fall early in the season. The best control treatment is to spray with Bordeaux in spring, followed by a second treatment after a month's interval.

APPENDIX XI

SPRAYING PUMP

(*Referred to on page* 657)

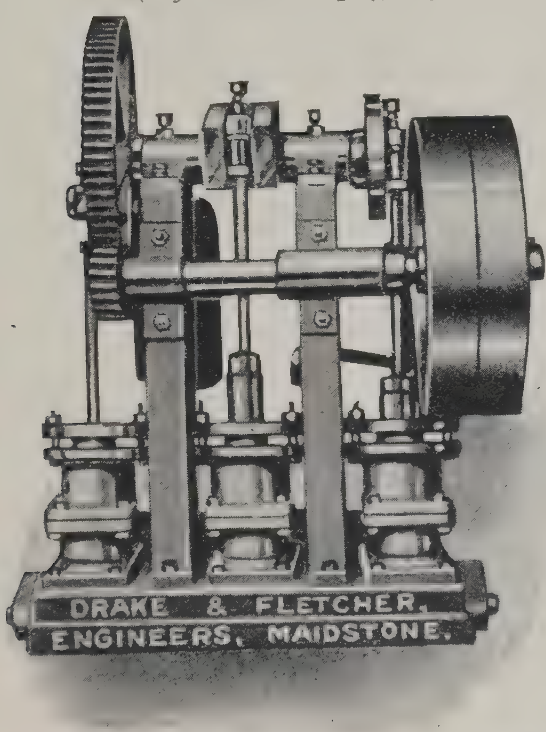


Fig. 301. Three-throw high pressure ram pump for large spraying outfits.

APPENDIX XII

PLUM LEAF-CURLING APHIS

Fig. 302. Commencement of attack on young branch of plum. (See page 313.)

APPENDIX XII—*continued*

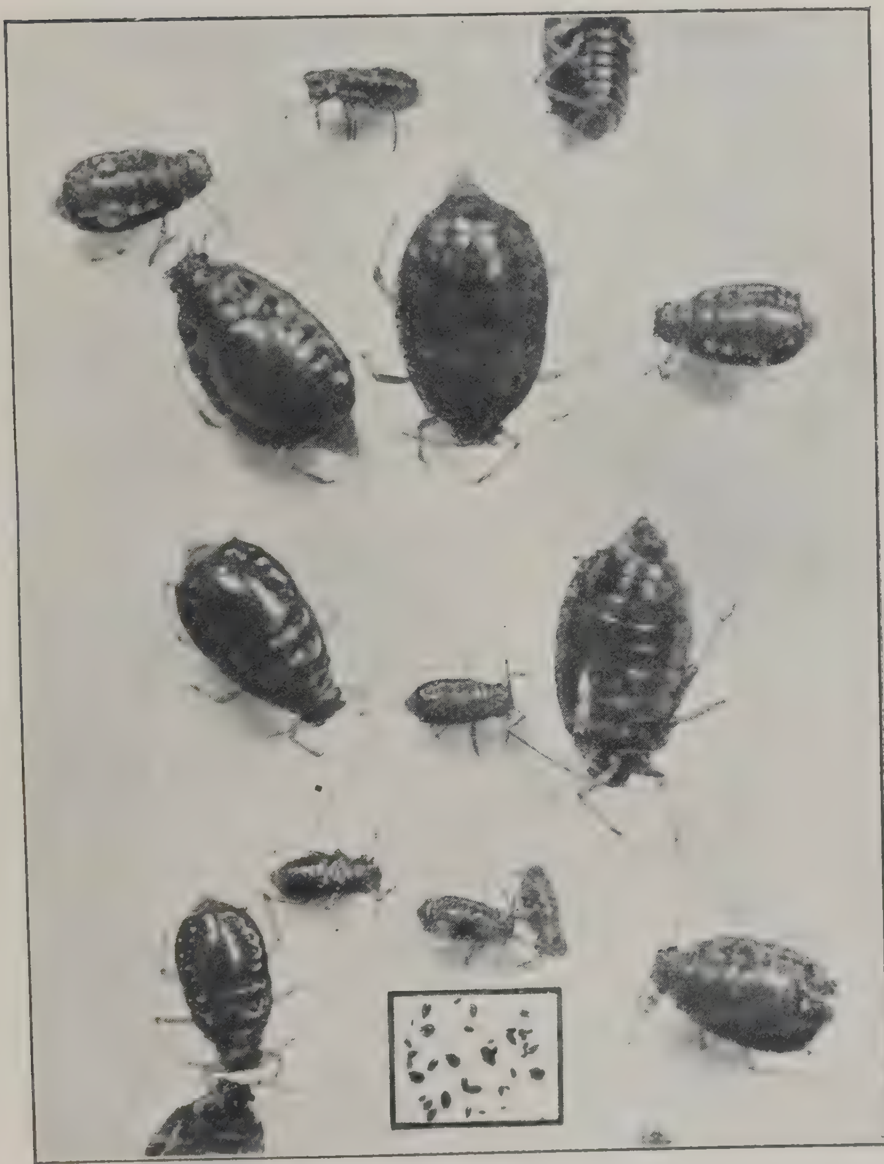


Fig. 303. Plum leaf-curling aphides magnified (× 15). Inset, natural size.
(See page 313.)

APPENDIX XIII

APPLE SUCKER (Psylla)

Fig. 304. Larval and nymph stages of Apple Sucker (Psylla) highly magnified (× 15). (See page 337.)

APPENDIX XIV

LACE-WING FLY

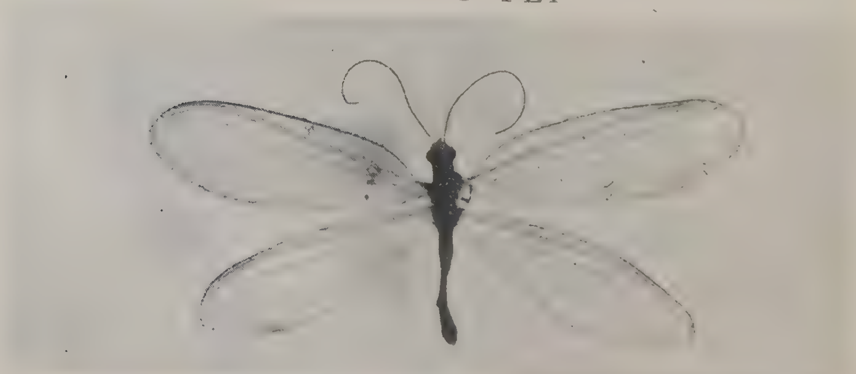


Fig. 305. Adult of the Lace-wing Fly, the larva of which is termed the "Aphis lion." (See page 469.)

GENERAL INDEX